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FRANK C. WIGHT
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Niagara Diversion Legal

THOUGH somewhat belated the official guarantee that the Niagara diversions are within legal limits is reassuring. The advocates of the large Chicago diversion were very free a year ago with charges of excessive diversion at Niagara, from which they apparently argued that Chicago should, too, be allowed more water than the law permitted. But the report by Major Reinecke and Mr. Johnston should set at rest all such charges. The treaty permits a diversion for power purposes limited to an amount "not exceeding in the aggregate a daily diversion" at the rate of 20,000 sec.-ft. on the United States side and 36,000 sec.-ft. on the Canadian. The wording indicates a concession to the daily peak demand, in that the instantaneous withdrawal may be greater than the specified amounts, but it does not go so far as permitting an annual aggregate at the specified rate as does the current permit for the Chicago diversion, which in addition sets an instantaneous withdrawal limit about 40 per cent above the average permitted. So the Niagara plants at certain times of the day may exceed the 20,000 and 36,000 sec.-ft. limits, but their daily total, the government deputies say, is within the law.

More Low Paid Government Engineers

RESENTMENT by government employed engineers at the persistent low salary scale they have to endure is spreading fast. To the organized protests by the city engineering forces of Chicago and New York may now be added those of the engineering employees of the state of Massachusetts. That state, as befits its thrifty New England nature, has a Commission on Administration and Finance, which acts as the watchdog of the state treasury. Like all such bodies it too frequently confuses penury with economy, realizing that applause these days can readily be gained by any government body that saves a penny today at the expense of a dollar's cost tomorrow. This body has turned down all the efforts of the state engineers to have established a salary scale at all compatible with either the work the engineers do or what engineers similarly engaged in private work are paid. Their refusal has stirred up the engineers to decisive action in the way of prospective legislation, to which they have been successful in drawing the approval of several influential state officials. Meanwhile a highway engineer in state employ has acquired considerable publicity for the cause by resigning his $1,800 job in charge of a $200,000 state contract to become a laborer on the road at higher pay—and, if the history of the state's engineering personnel is any criterion, a brighter future. This simple action has apparently impressed the newspapers of the state more than dozens of protests and through them the citizens of Massachusetts are being educated to the dangers of disintegration of their public works system by continued disregard of the common decencies of the relation between employer and and employed. Publicity is a weapon which government engineers should continue to use.

Once More a Ship Canal

RUMORS are prevalent in Washington that the idea of a ship canal approximately on the line of the New York State Barge Canal is gaining favor. Just who is in favor of it does not seem to be revealed at present, and the famous "unofficial spokesman," who functions equally well for President or bureau chief, won't come out into the open with the source of his information. Until he does no one need get very much worked up over the New York ship canal, and even if the proponent finally turns out to be one in the highest official stratum, the prospect for early construction need not cause much of a flurry among the manufacturers of earth moving machinery. Maybe the United States has a billion dollars handy to dig a 30 ft. ditch from the Lakes to the Hudson; maybe there can be found prospective shipowners who will be anxious to send their vessels down this narrow cramped channel; maybe there can be found some way to get the hundreds of heavily traveled railways and highways across the channel the hundred or more feet above the water necessary for clearance of a 30-ft. draft steamer—but amid this flock of "maybes" engineers will want much more than an inspired statement from Washington to get them much interested in the New York ship canal.

Maine Unbends a Little

IT IS hard to say whether the action of the voters of Maine two weeks ago, authorizing the Quoddy tidal power development, is an indication of a relaxation of the state's hitherto inflexible intention not to permit the export of energy generated by water power within the state. The Quoddy plan is different from anything else the Maine people have ever thought about. It is a tremendously large project, one which will take hundreds of millions of dollars and whose present possibility is very hazy, and it is besides an international development in which the state's power to set up an embargo is at least doubtful. But, at any rate, the vote is a gesture towards a liberality of thought which is hopeful for future liberality regarding power export. There is no place in our present day for such narrowmindedness as Maine has hitherto exhibited. Just as Pennsylvania and Ohio and Illinois and the rest of the states would not dare to put an embargo on the export of coal, so the water power states should permit the export of such energy as is generated within their borders. Not only is that a

necessary corollary to the consideration of the United States as a unified nation, but it is, like the old adage about honesty, the best policy. For by permitting export, each state will encourage power development, and power development for whatever use will lead more quickly to the growth of industry in the state than restriction of power in the hope that industry will have to come to where power is availab

Frivolous Bidding

TWO weeks ago bids were opened on a subway contract in New York City in which the lowest bid was roughly $5,890,000 and the highest $8,415,000, with two other bidders in between, one near the low but not too near, and one near the high. This wide discrepancy between high and low bidders is not peculiar to this one subway contract. In ten contracts for the New York subways this year alone, with an average of 6.4 bidders per contract, the sum of the low bids is $48,000,000 and of the high $61,000,000, an average difference of 27 per cent between low and high. The sum and the average typify the individual contracts. In each one the high bid is nearly a third more than the low, a matter in the average of $1,225,000 per contract.

Such bidding plainly shows that something more than the desire to do work is behind some of the contractors who bid. Subway work in New York is occasionally hazardous, but it is always repetitious. Hundreds of miles have been built, most of them by the same men who are now bidding, though they have not always been the principals in the earlier work. The low bids, as a rule, are fairly near the engineer's estimate and since no contractor would dare utter the heresy that an engineer is a better estimator than a contractor, there is no legitimate reason why any contractor should run up to the absurdly high figures that mark the higher range of all the bids.

Nor is this condition peculiar to the New York subway bidding. It is common and has been common for years in all contract awards. Special emphasis might be laid on the subway work because all the contracts are large ones, running into the $3,000,000 to $8,000,000 class, and percentages of difference in bids ought to drop with increase in the size of the bids. But every opening of bids shows a number of contractors submitting proposals which are obviously "complimentary." They are put in for various reasons: Because the awarding body asks for them in order to have the publicity of competition; because a high bid may make a friendly competitor's low bid look extraordinarily attractive; because of the long-shot gamble that maybe every one else will try the same trick and one of them, being low, will get an easy-money contract.

But because such careless bidding—careless because it is not made in good faith nor with any expectation of getting the contract—is common is no excuse for it. Indeed, it is doubtful if contractors ever stop to think that it is one of those things that is leading to the increase of day-labor work by some of our public bodies. The essence of the contract system is the competitive bid, though that is too frequently forgotten. If it were not that the public expects to get, through the urge for work operating on experienced constructors, the very best effort of these constructors toward lowering cost, which effort has initial expression in the low bid and final expression in efficient prosecution of the work—if it were not for this the public would be just as well protected by getting some experienced constructor to supervise the work at the public's expense, in other words by day labor. But the competitive bid puts the contractor on his mettle and assures the benefit of his efforts to the public. Private owners can and very frequently successfully do let contracts to a favored bidder merely on his past record and his assurance that he will do the work as cheaply as he can do it with a fair fee for the service. But public contracts from their very nature cannot be awarded this way, so if bids cease to be competitive, if a number of the bidders make proposals that are obviously frivolous, like some of the New York subway bids are, the public loses the protection of the competitive effort to get work and sooner or later this begins to impress public works officers and through them the public itself with the desirability of conducting work without the intervention of the contractor.

A recent circular of a surety bond company urges its contractor clients to be careful to avoid the complimentary bids. Its interest is based on the possibility of the contractor thereby destroying his own reputation for responsibility with the surety company, but the contractor might well consider when he is about to submit a bid, the success of which would be a distinct shock to him, whether in so doing he is not adding one more brick to the edifice which may some day come down to overwhelm him.

An Enterprise for the Future

COLUMBIA BASIN irrigation, long the storm center of politics and intrigue in the Pacific Northwest, is put on the shelf for the time being by the unfavorable conclusions of a special reclamation commission, noted on p. 502. Commissioner Mead and Secretary Edwards base their decision on the vastness of the development problem involved, not of the irrigation construction but the subsequent work of bringing in farmers, erecting houses, barns and towns, providing stock, and preparing the ground. The undertaking is too huge for present-day realization, they say. Their report is terse in the extreme, and on that account may not be read understandingly by people at a distance from the problem involved.

The project may be compared to a scheme for launching a new industrial enterprise. This would be an enterprise requiring $200,000,000 to $300,000,000 expenditure for buildings, and as much more for machinery, equipment and working capital. Half a dozen to a dozen years would be required to build and equip the works. But at the end of that time it would not be ready to produce; on the contrary, ten or twenty years more would be required before it was in shape even to pay taxes and interest on the bonds, not to mention accrued amounts. Before production would be in full swing, some 15,000 to 20,000 skilled workers with their families would have to be brought in, and several times as many other workers to provide for these. All this would have to be done in the face of an acute shortage of skilled labor in this particular industry, and despite the existence of numerous idle plants—idle because of lack of labor and markets. The

promoters of such an enterprise would undoubtedly be classed as visionaries, and would be turned out of doors by investors, even if they promised high ultimate returns and command of a large, stable market. But if the promoters should acknowledge that the huge works proposed could never even pay operating expenses on large-volume staple production and therefore would have to go into high-class specialty work, and that in any event the undertaking would probably pay only normal dividends, they would be called dangerous schemes.

Perhaps because of this unfavorable investment view, no attempt has been made, so far as we know, to organize and promote the Columbia Basin project on a business-like investment basis. Nor has the state of Washington made preparations to undertake the enterprise itself, although the wealth of the state, added to the newly created development itself, would furnish ample backing for borrowing funds even in such large amount, as long as the enterprise is sound. Instead, federal funds have been demanded for constructing the development—the public purse being considered elastic. The project has been compared to the Panama Canal, and the claim made that it should be developed for reasons of public policy, like the canal undertaking. The argument does not appear to have had much effect, and the finding now arrived at will hardly add force to it. Everything considered, it is well that the project has been definitely shelved. It should be allowed to sleep for a generation or two.

Utility Commissions and Legislatures

A COMMON misconception of the function of state utility commissions holds their object to be to lower rates and otherwise curb the utility companies, instead of to see that equity is done to both the companies and the public. This idea often leads to a demand for the abolition of commissions or the removal of individual commissioners after a rate increase has been granted.

Representative Martin Hays, of Brighton, Mass., has a different plan, but it seems to spring from much the same misconception for he declares that the "inhabitants of the Commonwealth are outraged at the recent decision increasing telephone rates approximately $10,000,000," and he has filed for introduction in the next session of the Massachusetts legislature "an Act to curtail the powers of the Department of Public Utilities." The views of one out of the thousands of State legislators that cumber our capitals are unimportant in themselves, but they are sufficiently typical of some current loose thinking to warrant consideration.

The effect of the Hays bill is to make the orders of the commission subject to a roll call of both branches of the legislature. Specifically this applies to increases or decreases in consumers' rates, to increases in capital stock, bonds or other indebtedness, and to increases or decreases of dividend and bond interest rates. The declaration filed with the bill states that "under the present law the commission seems to be beyond the control of the governor, the legislature or the public." Continuing, after a reference to the increase in telephone rates already mentioned, Mr. Hays declares: "The public must have a tribunal where it can appeal from unjust, unreasonable and oppressive acts of its appointive servants. The highest court of this Commonwealth is the Great and General Court, the Legislature. It is a thoroughly representative body and responsive to public requirements." After asserting that "cost of transportation, gas, electricity and telephone are higher than under like conditions in any other state" and intimating that this is due to "the skillful manipulation of high-priced attorneys upon the susceptibilities of members of a commission who do not properly safeguard the rights of the people," Mr. Hays asserts that "no such gouging would be possible where every member of the legislature must publicly vote on increases in rates, issuance of securities or establishment of dividends," and that "the legislature can be depended upon to be fair to capital honestly invested and prudently expended and allow a reasonable return upon such investment."

As Mr. Hays himself states, his bill would make the utilities commission a mere advisor to the Legislature.

The plan proposed is futile and unworkable; it breaks down by its own weight and weakness. Before adopting or rejecting the advice of the commission would each of the scores of members of the two houses review all the evidence in each of 125 or 150 cases acted on yearly by the commission? Otherwise how could the members of the legislature vote intelligently at each of the 125 to 150 roll calls? And if the members of a small body of commissioners, appointed solely to administer the utility laws of the state, may be subject to "skillful manipulation of high-priced attorneys," then how about the members of the legislature? Would the legislature set up and follow standards for capitalization and earnings applicable to the entire state? If not each case would have to be considered by the legislature on its individual merits, which would include traversing all the testimony taken by the commission and possibly the holding of legislative hearings, which would mean confusion worse confounded.

Moreover, although the declaration that the "highest court" of Massachusetts is "the Great and General Court, the Legislature" sounds well just before an election the fact is that the constitutionality of acts of that body are subject to adjudication by the courts of both the state and the nation—as would also be true of final rate control by the legislature.

Rather than attempt to pass on each order of its utility commission what the legislature of Massachusetts and those of other states might better do is to establish more definitely the principles to be followed in fixing base values of utility properties and the rate of return to be allowed on those values, as proposed by Bauer in his "Effective Regulation of Public Utilities." This would be going as far as our legislatures can profitably go in taking back the legislative functions which some think have been unwisely surrendered to the utility commissions. The precise limitations proposed by Mr. Bauer need not concern us here, but merely the broad principles he urges. A careful consideration of these might well precede any attempt either to abolish the utility commissions or to so curtail their powers as to rob them of finality and compel the legislatures either to go through a mere gesture of approval of every commission order or else a virtual going over again of all the testimony taken in every case.

Additional Drainage Works in Little River District

Retarding Basins and Enlarged Outlets—Parallel High-Level Ditches for Flood Flow and Low-Level for Lateral Drainage—Comparison of Floodways and Ditches

By E. S. Blaine
Resident Engineer, Little River Drainage District, Cape Girardeau, Mo.

MULTIPLE main ditches, retarding basins and the use of high-level flow-line ditches in preference to floodways for taking care of high-water flow, characterize the extensive additional works which are being carried out in the Little River Drainage District, in Missouri, to provide adequate drainage and flood control under conditions which have developed since the original works were constructed some ten years ago. Typical main and lateral ditches are shown in Figs. 1 and 2.

Division of Runoff—Two outlets serve to remove the runoff from this district, as will be seen from Fig. 4. All the runoff from a hill area of 1,120 sq.mi. is intercepted by the head-water diversion system and flows eastward across the north end of the district, discharging into the Mississippi River about four miles south of Cape Girardeau, Mo. But the runoff from 1,620 sq.mi. of flat land and 140 sq.mi. of hills finds its outlet south into Big Lake, just below the Arkansas line, where it is picked up by natural and dredged channels and emptied into the St. Francis River. This river in turn has its outlet in the Mississippi River near Helena, Ark. The major part of the new work is for interior drainage to the southern outlet and is independent of the works for carrying head waters on the north. A plain of high bottom land three to eight miles wide, known as the Sikeston Ridge, lies adjacent to the District on the east and extends south from the Commerce Hills to the Mississippi River at New Madrid, Mo. The Ozark Hills form the north boundary and the main drainage outlet is at the south into Big Lake, just below Hornersville, Mo.

Little River District Improvements—This great district, shown in Fig. 4, was described in *Engineering News* of March 18, 1915, p. 519, and Aug. 24, 1916, p. 342, together with its original drainage works. While the district has an area of about 835 sq.mi., its works have to provide for the flow from 2,880 sq.mi., including 1,260 sq.mi. of hill area and 1,620 sq.mi. of flat area. The original plan, adopted in 1909, took care of this very well for the district as a whole and under the conditions then prevailing. In recent years, however, it has been found that a few small areas have insufficient lateral drainage and that the main outlet channels are of insufficient capacity, largely owing to the redredging of tributary county ditches, thus bringing the runoff to these main channels more quickly than had been anticipated. In addition, increased facilities were needed for Caney Creek, with a hill area of 33 sq.mi., and for a small hill area of 7 sq.mi. in the northwest part of the district. These weak points were emphasized by the heavy runoff in 1921 and 1922.

As a result of such conditions some areas had less effective drainage outlets or protection from flood overflow than other areas assessed for equal benefits and paying equal taxes. At the annual meeting of the landowners in October, 1922, a demand was made for equalizing the facilities, and as the original benefits assessed amounted to $13,000,000, while bonds for only $7,000,000 had been issued, the assessment was ample to take care of the new work. In order that the new bond issue could be based upon the original assessment, the circuit court drainage law had to be amended and this amendment then tested in the circuit court and the state supreme court, both of which rendered favorable decisions.

In anticipation of an enlargement of the original plan, to regulate hill runoff and to increase the capacity of the main outlet channels, the engineering department had maintained rating stations in co-operation with the Bureau of Drainage Investigation, U. S. Department of Agriculture, and had worked out various plans. The revised plan was filed in January, 1924, but action was delayed by litigation as set out above. Contracts were let in September and October and construction was begun in November, 1924.

FIG. 1—ENLARGEMENT OF LITTLE RIVER
Head of Ditch No. 251, which is the river channel.

Work done under the original plan consisted of 640 miles of ditches with 4- to 123-ft. bottom width and 33 miles of spoil-bank levees, besides the headwater diversion system with 48 miles of channel and 47 miles of levees, involving 43,000,000 cu.yd. of excavation. For the Stoddard and Bollinger County addition, completed in 1924, there were required 48 miles of ditches with 4- to 40-ft. bottom width and eight miles of levee, with 1,700,000 cu.yd. of excavation. The new work requires the clearing of 5,880 acres of right-of-way, and 21,100,000 cu.yd. of earthwork. This earthwork includes 18,900,000 cu.yd. for 157 miles of new ditches and 181 miles of levees, 1,700,000 cu.yd. for enlarging 32 miles of old ditches, and 500,000 cu.yd. for cleaning out 100 miles of lateral ditches to the original section and grade.

Caney Basin—This detention basin, regulating the flow from Caney Creek, reduces the yearly maximum flow to 10 per cent of the unregulated maximum. At the site for the dam the drainage area of Caney Creek is 33 sq.mi., nearly all of which is steep hill land. The water from this area could not be diverted into the Mississippi, as has been done with most of the hill area, and it was impractical to provide a channel through the district to take care of anything like the maximum runoff, so that unless this peak flow was reduced a large area would continue to be overflowed.

A retarding basin solves the problem very well and its position is indicated in Fig. 4. The valley narrows

at the point where the creek leaves the hills and makes a good location for an earth dam. The north side of the valley is limestone, providing a good foundation for the reinforced-concrete outlet and spillway structures. The main part of the dam, Fig. 3, is 1,100 ft. long and at the lowest part of the valley it is 40 ft. high. It is being constructed with a puddled core, a crown 20 ft. wide and side slopes 1 on 3. Twin conduits 39 in.

FIG. 2—LATERAL DITCH NO. 29

square and 270 ft. long, provided with a trash rack, drift boom and stilling pool, will carry the discharge from the retarding basin until the water reaches El. 360 (15 ft. below the top of the dam), when the spillway will come into play.

Jenkins Basin—All the water from a 19-sq.mi. area (12 sq.mi. rolling and 7 sq.mi. steep hill land) discharges through a large natural channel into ditch 24. The ordinary peak flow, occurring once to three times a year, is 2,000 sec.-ft., and although of short duration it is sufficient to back up the water and cause overflow. About half a mile below the mouth of the channel the ditch traverses a low valley between Crowley's Ridge and Ringer Hill, and by building levees across it this valley has been converted into a retarding basin, Fig. 4, which provides sufficient storage to flatten the discharge curve and reduce the peak flow from 2,000 sec.-ft. to 200 sec.-ft. Four small hill streams now discharge into this basin instead of into ditch 24. As the basin levees dam this ditch, a new ditch, 287, was built around it, east of Ringer Hill, to take the drainage from above, as shown.

Castor River Outlet—The only remaining hill area of importance is that draining into Castor River below the levee of the main diversion channel near Greenbrier, Mo., where the channel diverts the flow from 441 sq.mi. of steep hill area. From this point to its connection with ditch 1, about 2½ miles west of Morehouse, the river provides an outlet for 206 sq.mi., about half of which is hill land. The diversion noted made a large channel available to carry flood waters down to the connection with ditch 1, where the peak discharge amounts to 3,500 sec.-ft.

The hydrograph of this stream at its intersection with ditch 1 is comparatively flat and it would take a very large storage basin to reduce the flow materially. Such storage basin was economically impracticable, as the river valley is wide and flat and largely under cultivation. It was necessary, therefore, to carry the flow of 3,500 sec.-ft. through the district, utilizing 38 miles of ditch 1 by closing openings and low points in the spoil banks to form levees. Three railroads will have to raise their tracks 3 to 7 ft. to clear the new flood level in this ditch.

Design of Outlet Channels—From a number of hydrographs at ten regular gaging stations, supplemented by stream gagings following heavy rains, it appeared that the maximum drainage necessary for the flat lands in the district would be indicated by a curve represented by the following formula, in which Q is the unit runoff in second-feet per square mile and M is the number of square miles drained:

$$Q = \frac{40}{\sqrt{M}}$$

The amount of runoff to be provided in farm drainage varies considerably, depending upon the degree of improvement and the damage that would result from overflow. Farm drainage is seldom complete enough to prevent all overflow, as the cost would be prohibitive and short periods of overflow on farm land are not serious during the time of the year when the heaviest rainfall usually occurs. If a drainage system is well balanced, any overflow occurring after unusually heavy rains will be well distributed and of short duration. On the other hand, with an unbalanced system, the upper part may have little or no overflow while the lower part may be flooded too often and for too long a time to permit profitable cultivation.

Since the new work in the district is for the purpose of balancing an unbalanced drainage system and equalizing the drainage in proportion to the benefits assessed, it does not contemplate increasing the capacity of the whole system in accordance with the curve noted above. Most of the large districts that drain into the Little River District have redredged their ditches or planned this work, so that it is not probable their flow will increase for several years.

Except in a few cases, the design of the new ditches

FIG. 4—BUILDING THE CANEY DAM

was not a question of providing capacity to conform to the new runoff curve, but to provide capacity to take care of measured quantities that are discharged at different points. However, on all outlet channels provision has been made to permit their size being increased to that required by the new runoff curve, without rehandling any of the material moved at this time. This is done by requiring that all the spoil be placed on one side, or requiring berms 40 to 75 ft. wide on one side.

New Ditch Sections—An examination of cross-sections of existing ditches which had become stable showed the prevailing side slopes to be 1 on 1½, and this slope was adopted, except that 1 on 2 was used where cuts of 15 to 17 ft. occurred or where ditches traversed an old bog. The width of berm on the new work varies from 10 to 75 ft. Where widths of 40 ft. or more have been specified, they are to permit future enlargement, as noted above.

On small ditches having side slopes of 1 on 1½, or flatter, and where no scour or much caving of banks is to be expected, berms 15 ft. wide have proved ample and this width was used. For large ditches with heavy earthwork, a berm of 20 to 25 ft. has been specified along the side of the ditch where most, or all, of the spoil is to be placed. In some places wider berms were desirable, but would have changed the size of the excavation equipment and materially increased the cost. In using Kutter's formula for the new dredged channels it was decided to use 0.030 as the value of n.

Comparison of Ditches and Floodways

Ditches and Floodways—An important point to be determined was the best method of carrying large quantities of water for long distances. Where right-of-way is reasonable in cost and practically a plane surface, it is practical, under certain conditions, to carry water above the ground surface between levees. There are two general methods of doing this. The first consists of providing two parallel levees a suitable distance apart with no channel area, or comparatively small channel area, below the ground surface between the levees. This is generally known as a floodway. The other method consists of a comparatively large excavated channel with levees along each side made with the material removed from the channel. This we have termed a "high flow-line ditch."

The board of engineers for this district believes that the best use of a floodway is in connection with a channel which will care for ordinary floods, leaving the floodway area available to care for comparatively infrequent high floods crests. If a channel was excavated large enough to care for a maximum flood several times as large as the ordinary flood, the low-water flow would not maintain it and probably the maintenance would be much greater than for a floodway.

In most cases where a floodway is used, especially in flat country, it is necessary to bring the water to the floodway, flowing at or below the ground surface in excavated or natural channels and to carry these channels a suitable distance down into the floodway to permit the water to reach the high level necessary for floodway flow. This transition from channel to floodway is a serious disadvantage if the flood water carries an appreciable amount of silt, since there is a marked decrease in velocity between the flow in a channel 10 or 11 ft. deep with a value of n of about 0.030, and a floodway with 7 or 8 ft. depth of flow and a value of n about twice as great. The reduced velocity in the transition section tends to cause a deposit in a comparatively short time and this means heavy maintenance expense almost annually to keep the sediment from causing the transition section to move upstream above the upper end of the floodway.

The same condition exists to some extent when it becomes necessary to bring the flow from a low-level ditch into a high flow-line ditch, but instead of the flow having a velocity at all stages low enough to drop silt, as would be the case when the tributary ditch enters a floodway, such velocities would occur for only part of the flood. At medium stages, the velocity would be substantially the same in the main channel and in the tributary. In many cases the flood crest from the tributary would reach the high flow-line outlet canal ahead of the crest in the outlet canal and might tend

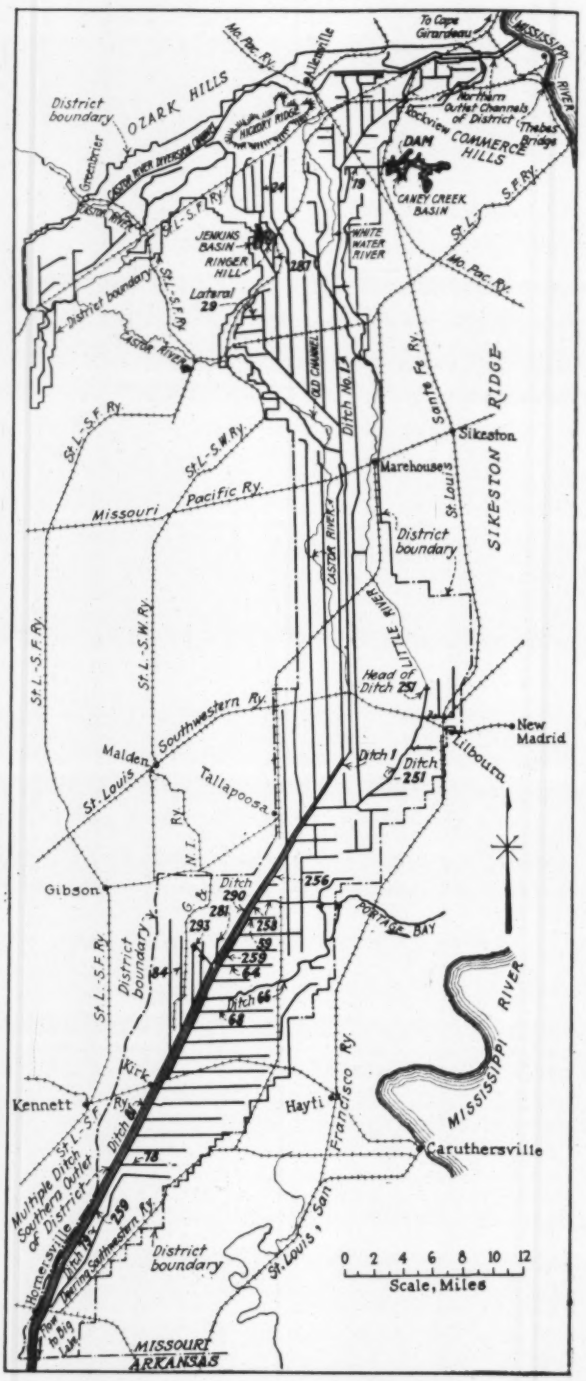


FIG. 3—LITTLE RIVER DRAINAGE DISTRICT, MISSOURI
Note the multiple ditch arrangement for outlet at south end.

to cause scour instead of silting through the transition section during part of a flood.

Cleared Floodways—Other disadvantages of a floodway are its inefficiency and its maintenance cost. Our experience has been that, in alluvial valleys where the soil is fertile, the large timber should be left standing to shade out the dense growth of sprouts and weeds which occurs if the timber is cut. An exception to this would be a condition where the floodway came into play at very infrequent intervals, or between crop

seasons, so as to permit profitable cultivation. If the timber is left standing in such a floodway, having a fall of 1 ft. per mile, a value of n much less than 0.075 cannot be expected.

If the floodway is cleared clean, the value of n can be reduced to a minimum of 0.040, but at the end of one growing season the sprouts and weeds will change this value to about 0.075. It must be cleared annually to hold the value of n even at this figure. This clearing would cost from $5 to $10 per acre, which becomes a sizable item when the floodway contains several thousand acres, and in this case it is not practical to maintain an organization large enough to clear it annually if it is possible to work in the floodway only a few months out of each year.

Compare Floodway and Ditch—These values of n are for depths ordinarily used in this type of floodway, say 5 to 8 ft. As an illustration of the inefficiency of a floodway, compare a ditch 10 ft. deep and base of 120 ft. using $n = 0.030$ with a floodway using $n = 0.075$, both with a slope of 1 ft. per mile. The average velocity in the channel will be 3 ft. per second in the channel and about 1 ft. in the floodway. A velocity of 3 ft. per second will maintain the channel and even cause some little scour if the sprouts are kept out of it, while the silt carried in suspension will not be deposited. With the floodway, the opposite is the case.

If a floodway is to carry several feet of water for periods of two weeks or more, it has another serious disadvantage, especially if the country is underlain with sand at a depth of 5 to 10 ft. We have found that a 6- to 8-ft. head of water above the ground surface for a period of three weeks will cause sand boils and seepwater for a distance of ¼ to ½ mile back from the levee, depending upon the thickness of the clay over the sand. A field covered with seepwater cannot be said to be drained.

The space between the spoil banks of a ditch and above the natural surface forms a very economical waterway. It not only has a low value of n itself, but when it is used for flow it causes an increased velocity in the channel beneath it. A channel large enough to carry ordinary flood flow and with a reserve area for greater floods above the ground surface and between levees on each side, made from the material removed from the channel, has all the advantages of a floodway without its disadvantages.

This can be illustrated by an example typical in this district. Using $n = 0.030$, $S = 0.00020$, channel 10 ft. deep with 120 ft. base and 1 on 1½ side slopes, and 8 ft. of water over the natural surface, or a total depth of 18 ft., the average velocity in the floodway area above the channel will be 4.8 ft. per second, as compared with 1.2 ft. for 8 ft. of water on an ordinary floodway. At the same time the increased depth will increase the capacity of the ditch below the ground surface about 60 per cent.

High Flow-Line Ditches—For the reasons set out above the high flow-line type of ditch was adopted for carrying large quantities of water for long distances through the district. When such ditches are used it becomes necessary to provide a separate low flow-line ditch to pick up the lateral drainage. Since ditches with a base of 125 ft. have proved to approach the economical maximum for dragline excavation, it was necessary to provide parallel ditches to carry the flow.

Where the water in the parallel ditches will flow at or near the same level they can be placed as close together as the area for spoil will permit, but where there is much difference in head in these parallel ditches, as in the Little River District, it was necessary to decide upon the minimum spacing that would prevent serious sand boils in the low-level ditches. On drainage work in Florida, Mr. Hidinger, chief engineer of this district, found that the distance between the exposed sand surfaces in two parallel ditches should be at least 25 times the difference in head, and this fixed the minimum distance between the ditches.

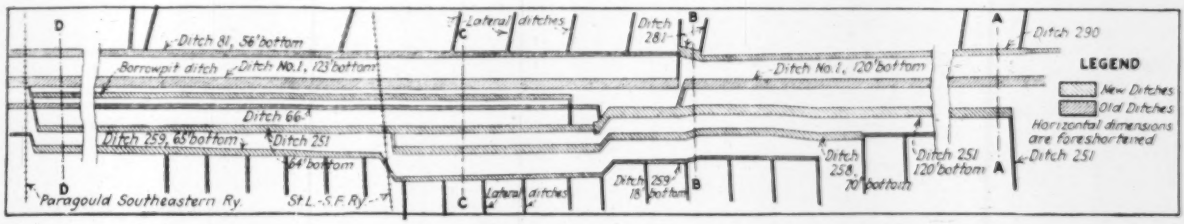


FIG. 5—PLAN OF MULTIPLE-DITCH OUTLET

Another factor entering into the design was the desire to use the existing main ditches to best advantage and to avoid enlarging them. To increase the width of an existing channel means the removal of all or part of the spoil bank along one side. This work is much more expensive than new excavation, because of the stumps and logs buried in all these old spoil banks, besides the large amount of material to be moved to get a comparatively small increase in size.

For this reason, in the adopted plan for increasing the capacity of the outlet system, existing ditches are used by cutting them at points where they have their full capacity and diverting the flow into other channels. Also on part of ditch 1 the openings in the spoil banks were filled, changing a low flow to a high flow-line ditch.

Multiple Ditches Form Outlet—From Fig. 4 it will be seen that four and then five parallel lines of ditches form the main outlet, discharging into Big Lake, four miles below Hornersville, at the Arkansas state line, which is the south boundary of the district. A plan of this multiple-ditch arrangement is shown in Fig. 5, with typical cross-sections in Fig. 6. This arrangement comprises ditches 1, 251, 258 (with its extension 256), 259, 66 and 81 (with its extension 290). The combined outlet capacity at the southern outlet is 18,645 sec.-ft.

Ditch 1—The first work on this ditch is its enlargement from ditch 8, near Rockview, at the north end of the district, Fig. 4, to the Caney Basin, beyond which it is made adequate by reducing the flow from Caney Creek by means of the retarding basin previously

described. Further down it picks up the diversion of Castor River and a capacity of 5,000 sec.-ft. is provided for by closing the spoil banks so as to form levees, the lateral drainage being diverted to other ditches. At lateral 64, a dam will be built and the entire flow from above diverted into the new parallel ditch 251. Below the dam the old channel, 150 ft. wide on top and 10 ft. deep, was built with tight spoil banks down to the state line. Just below the dam, a 4,000 sec.-ft. flow enters from new ditch 293, and as ditch 1 has a capacity of more than 5,000 sec.-ft. a spillway was built opposite the end of lateral 68 to permit a flow of 1,000 sec.-ft. from the new main floodway on the east.

Ditch 251—This was originally a diversion of the old dredged channel of the Little River near Tallapoosa, but the redredging of county ditches draining into the river made it necessary to provide for a flow of 2,000 sec.-ft. near Lilbourn and 3,300 sec.-ft. where this ditch reaches ditch 1. The base width of 251 is increased, therefore, to 90 ft. at the head and 120 ft. where it turns parallel with ditch 1. Below this point it will have tight levees on both sides, but the water level will be lower than that in ditch 1, until at the dam already noted 251 will receive the entire flow of ditch 1.

The flow just below this point, amounting to 9,300 sec.-ft., is carried in the high flow-line ditch for 2½ miles to where old ditch 66 comes in from the east. Here the old channel of that ditch is utilized and used in connection with ditch 251 and the new borrow pit ditch between 1 and 66. The flow from ditch 258 enters just north of the St. Louis-San Francisco R.R., near Kirk, Mo., this being the last tributary ditch. The total capacity of ditch 251 and its floodway below the junction of ditch 258 is 10,300 sec.-ft.

Ditches 256, 258 and 259—Ditch 258 was planned primarily to divert the concentrated flow coming down the dredged channel of Portage Bay and the old channel of Little River. It carries 2,000 sec.-ft. and discharges into ditch 251 just north of the railroad, near Kirk. Ditch 256 is small and has a base of 12 to 14 ft.; it serves as an outlet for lateral drainage along the east side of ditch 251, north of ditch 258.

Ditch 259 is the outlet for all lateral drainage east of the main outlet ditches from lateral 59 south, and is designed to carry the flow below gound surface down to lateral 78, where it beccmes a high flow-line ditch. The base width increases from 4 ft. at lateral 59 to 63 ft. at lateral 78, where it has a capacity of 1,445 sec.-ft. It has an outlet in the Elk Chute outlet ditch, which forms part of the big floodway extending down into Big Lake just south of the state line.

Other Ditches—Ditch 290 is the new outlet channel for the laterals along the west side of the main ditch 1, from lateral 40 down to ditch 293, where its flow enters ditch 1 just below the dam to be constructed in that ditch. Its base width varies from 10 ft. at the upper end to 60 ft. at the lower end. Ditch 293 diverts 4,000 sec.-ft. into main ditch 1 just below the dam and leaves the old channel of ditch 81 available for lateral drainage below the diversion point. Due to the proposed capacity of the tributary county ditches, ditch 293 provides for the runoff requirements of the new curve. Ditch 84 is being enlarged for the same reason.

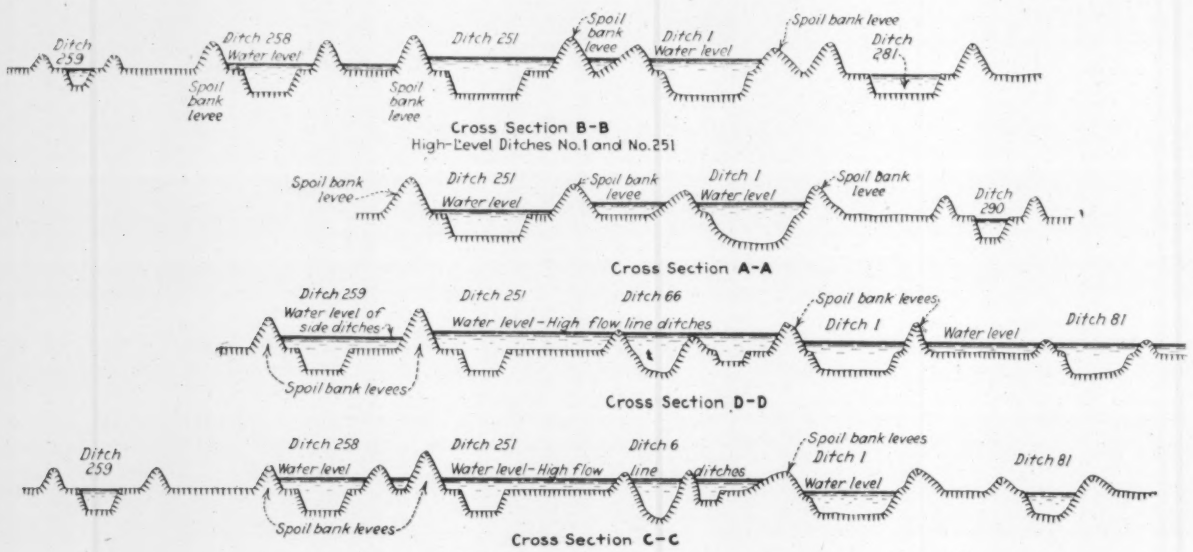


FIG. 6—CROSS-SECTIONS OF OUTLET DITCHES FOR FLOOD FLOW AND LATERAL DRAINAGE

Engineers—For the Little River Drainage District, Daniel W. Mead is consulting engineer; L. L. Hidinger, president of the Morgan Engineering Co., is chief engineer. William Mulholland, hydraulic engineer, did most of the designing for the new channels. The writer is resident engineer and has charge of the improvement work now under way, which is estimated to cost $3,500,000 and is to be completed by January, 1927.

Stevens Monument Dedication

In the article on the Stevens Monument in the issue of Sept. 10, p. 428, in the second column, the typography seems to indicate that the indented paragraphs, starting "The engineer's service to his fellow man is usually unobtrusive," were part of an address delivered by Ambassador Morris. This is not a fact. These paragraphs are a part of the address of Robert Ridgway, president of the American Society of Civil Engineers, and not his quotation from Mr. Morris.

Errors More or Less Common in Steelwork Designing

Experience Notes on Some Faults of Oversight and Misconception Producing Weak or Wasteful Construction

BY ROBINS FLEMING
American Bridge Co., New York

BECAUSE two beams of equal strength have the same section modulus, it is sometimes assumed, in splicing plate-girder webs for moment, that the combined section moduli of the splice plates should equal that of the web plates they cover. This would be true if the intensity of stress in the extreme fibers of the splice plates were the same as in the extreme fibers of the web plate, but not otherwise. It is the combined moments of inertia of the splice plates that should equal the moment of inertia of the web.

Beam-Web Reinforced—Rolled beams with concentrated loads near the ends may have sufficient strength for bending moment but their webs may be weak for shear. Designers make a mistake if they proportion reinforcing plates for the same intensity of shearing stress as is permissible for the web. The intensity of shear, either horizontal or vertical, at any point in the web of a beam is expressed by the equation $h = v = VQ/I_c t$, in which V is the total vertical shear on the vertical section through the point considered, Q is the statical moment of the section included between the horizontal plane through the point considered and the extreme fibers on the same side of the neutral plane about the neutral axis, I_c is the moment of inertia of the reinforced beam, and t is the thickness of the web of the original beam. It is noted that V, Q and t are fixed for any point along the longitudinal edges of the reinforcing plates, also that above and below these edges only the web with its original thickness t can resist shear. To keep the intensity of shearing stress within allowable limits the reinforcing plates must be designed for I_c; that is they must be designed to take bending as well as shear. A neat method for obtaining their thickness is given by Abraham Frank, "Reinforcing the Web of Rolled Beams to Carry Excessive Shear," *Engineering News-Record*, Oct. 9, 1924, p. 959.

Location of Neutral Axis—An erroneous theory of flexure occasionally put forth is that the moment of the horizontal forces on one side of the neutral axis is equal to the moment of those on the other side. The compressive stresses on one side of the neutral axis must equal the tensile stresses on the other side, but in unsymmetrical sections the moment of the compression stresses is not equal to that of the tension stresses.

This error has considerable historic interest. Prof. A. J. DuBois in the first edition of his noteworthy book, "The Strains in Framed Structures," 1883, writing of flexure in beams, says, "the neutral axis passes through the center of gravity of the cross-section." In the second edition he added a footnote: "This is not strictly correct. The neutral axis should be so placed that the moments of inertia of the sectional areas above and below it are equal. For symmetrical sections, this gives the neutral axis at the center of gravity as stated. For unsymmetrical sections the difference may be disregarded." This erroneous footnote after a spirited and lengthy discussion was omitted in subsequent editions of the book.

Flat-Bar Tension Members—It is inadvisable to assume that each of a pair of short flat bars with riveted ends, under the usual methods of fabrication and erection, will take equal tension. In the lattice girders of an elevated structure where this was done many of the bars had to be replaced. A small difference in the lengths of two 5-ft. bars will cause trouble. For lengths of 15-ft. they may adjust themselves to pull alike. Shapes should be used for tension members in light riveted structures.

Ineffective Bracing—"An error very often made is to brace one weak member by connecting it to another equally weak. When this is done by a triangular system, that cannot change its shape without shortening or lengthening one or more of the braces, effective bracing can be accomplished; but when the system is in parallelograms, this is not the case. Two columns connected by a horizontal strut are not effectively braced, nor are they shortened in their effective length as compression members, for both columns may deflect horizontally without resistance from this strut" (Godfrey, "Engineering Failures and Their Lessons"). The foregoing is quite pertinent. It also applies to rows of roof trusses connected by longitudinal braces. In rows of columns or struts the end bays at least should be diagonally braced, and the struts in intermediate bays should be designed to carry thrust to these end bays. It may be mentioned here that more structures have failed from lack of bracing than from any other cause.

Weak Details—A common error in structural design is the neglect of details. Especially is this true of wind bracing. Stresses have been calculated and members proportioned with care while the details had less than one-half the strength of the members connected. The kneebrace is another instance where connections at ends are often inadequate. From a multiplicity of other faulty details only the lack of proper provision for eccentricity will be mentioned. (For a number of cases of failure, see Godfrey's book, previously quoted.)

Unbraced Compression Flanges—In spite of many warnings an error still common is the neglect of bracing the top flanges of girders and the top chords of trusses against lateral deflection. Using the tabular strength of beams without staying the compression flange against side motion is sometimes done. The top chords of pony bridge trusses when no knees are used at panel points are not always figured as compression members for the entire length unsupported. Skylights and monitors often leave the top chords of roof trusses unbraced for a longer l/r in a horizontal than in a vertical direction. In deciding upon the l/r of compression members care should be taken that they are braced at the ends of lengths taken; if not, calculations should be made accordingly.

Cars for Tracks of Different Gages

To permit operating through cars on the French railways, with a gage of 4 ft. 8½ in., and the Spanish and Portuguese railways, with a gage of 5 ft. 6 in., a system of interchangeable axles has been introduced by the Northern Ry. of Spain, the change being made at Irun, the frontier station. Before the World War these through cars were handled by a private company, but the railroad now controls the system and will handle any cars that have the necessary facilities.

Report Against Columbia Basin Irrigation Project

Study by Mead and Edwards Based on Four Previous Investigations Indicates Development Not Now Warranted

THE TIME has not arrived for building works to irrigate the Columbia Basin lands, according to a special commission which has just reported to the Secretary of the Interior. The commission (Dr. Elwood Mead, commissioner of reclamation, and J. H. Edwards, assistant secretary of the interior) was charged with the duty of reaching a general conclusion as to whether the project is feasible and desirable, and recommending the policy to be adopted by the department. It reports cost figures intermediate between those computed by the Columbia Basin Commission (of the state of Washington) some years ago and those found by engineers of the Reclamation Service in later surveys. While the cost per acre is very much higher than that of any existing reclamation project, the commission bases its conclusion not on the cost but on the excessive size of the proposed development and the impossibility of planning a development program for so large a project.

The commission's report is the final report on investigations directed by Congress in 1923 and in part states:

Gault Report—Homer J. Gault, for many years an engineer in the Reclamation Service, was selected to conduct the work in the field; he made a thorough survey and investigation of the engineering problems of the project during 1923, being assisted by soil experts from the Department of Agriculture, and representatives of the Geological Survey who made studies of the water resources and of geological conditions as related to the location of various features. Mr. Gault's report was submitted in March, 1924. In this he outlined the result of his field work, discussed various alternative plans, and included the findings of the soil, geological, and water experts. A summary of the two alternative projects submitted by him is contained in the table:

COMPARISON OF GRAVITY AND PUMPING PROJECTS

Plan	Gravity	Pumping
Irrigable area, acres	1,406,000	1,133,000
Estimated cost	$325,340,790	279,310,420
Cost per acre	$231 40	$246 58
Interest on cost at 5 per cent	11 57	12 33
Operation and maintenance charges and depreciation	2 66	4 65
Sum of annual costs per acre	14 23	16 98
Commercial power at Grand Coulee, hp.		(*a*) 545,000
Difference in power possibilities, hp.		(*b*) 316,000

(*a*) Without storage. (*b*) With storage for power.

In Mr. Gault's report he calls attention to his omission of the following economic features:

"There are a number of pertinent subjects that are not discussed in this report, some of which are:

(a) Restriction of speculation in land;
(b) Organization of irrigation district;
(c) Means of financing the project;
(d) Terms of repayment;
(e) Limitation of land ownership;
(f) Probable rate of settlement;
(g) Market for and value of power produced;
(h) Feasibility from financial standpoint;
(i) Demand for irrigated land;
(j) Capital required by the farmer."

Reviewing Board—The report was reviewed by a board of engineers taken from the staff of the Bureau of Reclamation, the members being A. J. Wiley, James Munn, and J. L. Savage. Their report devotes itself largely to a discussion of the reasons for the large increase in the estimates in the Gault report over those of former reports prepared under the direction of the state of Washington. Their conclusion was that this arises from differences in the estimates as to carrying capacities of the canals, the quantity of water required, its losses in transit and allowances for overhead expenditures and contingencies; and that the Gault report presents a fair estimate of cost under the conditions prevailing at that time.

Second Review and Reinvestigation—On further consideration it was decided, however, by your commission to have a further review of Mr. Gault's report and an independent investigation of the project which would include, along with engineering features, the settlement and farm development problems. This was required to make this report conform to the recommendations of the Committee of Special Advisers on Reclamation. This Board of Review was therefore selected, to include men who were not only eminent as construction engineers, but who were also familiar with the economic and agricultural aspects of reclamation. It was composed of six members: Louis C. Hill, of California; Charles H. Locher, of Maryland; Richard R. Lyman, of Utah; Arthur J. Turner, O. L. Waller, and Joseph Jacobs, of Washington. The report of this board, submitted in February, 1925, considered five different schemes of development. The one favored embraces 1,224,000 acres which with the exception of 170,000 acres of pumping lands is to be irrigated by gravity, using the waters of the Pend Oreille and Spokane rivers.

The construction cost of the works is fixed at $193,360,000, which is $158 an acre. This estimate includes provision for drainage and contemplates the lining of canals to the border of each unit. The reduction in cost below that of the Gault estimate is accomplished principally by changes in engineering design, including: (a) Utilizing return flow and lining all canals, thus reducing diversion requirements and effecting large saving in size and cost of main canal system; (b) readjustment of gradients of main canal, reducing cost of tunnels and siphons; (c) utilization of Spokane River with Coeur d'Alene storage as an auxiliary water supply.

An alternative plan which would use Priest Lake as a storage instead of Lake Coeur d'Alene is included in the engineers' report, the cost being slightly larger.

This report agrees with previous reports in regarding the project physically feasible; the land is fertile, the water supply adequate, and climatic conditions make possible large yields of general farm crops, and a variety of orchard and garden products. The outstanding feature is the attention given to the agricultural and economic requirements of the project along the lines of the recommendation of the Committee of Special Advisers on Reclamation. Two of the board's economic conclusions contained the following recommendations:

> "That the state should assume its proper share of responsibility for collecting payments from the settlers, and should also bear its proper share of the losses, if any, incident to the development of the project.
>
> "That the government should clear and level the land and provide a reasonable financial credit for necessary farm improvements. Also as a guarantee against land speculation, and to insure that the settler secures the land at its fair value, that the government acquire title to all the irrigable land within the project."

Commission's Conclusions—Your commission has no doubt that the time will come when local and national interests will require the construction of these works, and the utilization of these immeasurably valuable resources. It does not believe, however, that this time has arrived; or that the Bureau of Reclamation is possessed of either the information or the experience needed to formulate a development program as costly and complex as the one outlined and advocated in this report.

So far as construction is concerned the procedure of the past could be followed, but building these irrigation works would not of itself insure solvent development or create real opportunities for settlers. Past experience in this and other irrigated countries is conclusive that solvent reclamation requires a program of settlement and farm development.

We are in accord with the essential features of the settlement and farm development program outlined in this report and believe that its economic features are sound and feasible. This would involve control of the prices at which privately owned land would be sold either through purchase by the authorities who build the work or through securing control for settlement from private owners. The subdivision of over a million acres of land with about

20,000 farms would have to be thought out and settlers secured who have the equipment and experience needed to cultivate this land, so as to secure satisfactory returns. The report of the last reviewing board states that financial aid and practical advice to settlers are essential to successful development of this project. The methods of doing these things are still largely untried in this country and the first attempts to utilize them should be on a small scale. Only after enough experience has been had to determine what can be wisely and safely attempted, should they be applied on as gigantic a scale as will be necessary in the development of this project.

It is believed that the Gault report and the reviewing report should be published. The information will be of great value to all directly interested. It will inform the nation at large of some of the requirements of future reclamation policy. No recommendation looking to further action by Congress is made.

Girder Discarded for Arch in Grade Separation

IN THE construction of a railroad overcrossing at Columbus, Ohio, recently, concrete arch and steel plate-girder designs were worked out in competition with each other, under somewhat unusual circumstances,

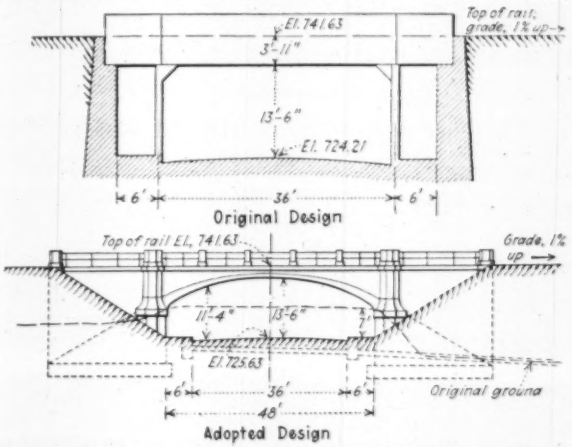


FIG. 1—GIRDER AND ARCH DESIGNS FOR OVERCROSSING

and the arch design was adopted. The crossing is located on the west side of Olentangy River, on the grounds of the Ohio State University, and carries the university spur track. The character of the neighborhood makes good esthetic effect important, and the arch design was preferred largely for this reason. The advantage of eliminating curb columns was also a factor in the choice, however. The construction costs of the two designs were practically the same.

When the separation of grades at this crossing was first proposed, a steel girder design as shown in the upper part of Fig. 1 was prepared for the board of trustees of the university. Prof. C. T. Morris, of the university, on seeing the design suggested that an arch could be built for little or no greater cost, giving better appearance and eliminating objectionable curb supports, if slight concessions as to required height of clearance over the sides of the roadway were made. The county engineer questioned the possibility of designing an arch of satisfactory clearance height without increasing the distance from crown of roadway to top of rail, but agreed to a reduction of clearance at the curb line to 11 ft. The design as subsequently worked out by Professor Morris reduced the vertical distance between street and railway grade by 17 in., and gave a clearance height at the curb line of 11 ft. 4 in.

In this design the arch intrados was made a true ellipse, although this is not the exact curve of maximum economy. The added beauty was thought to offset the slight increase in concrete yardage.

A loading of Cooper's E60 was assumed for the design of the arch, adding half the amount of impact and

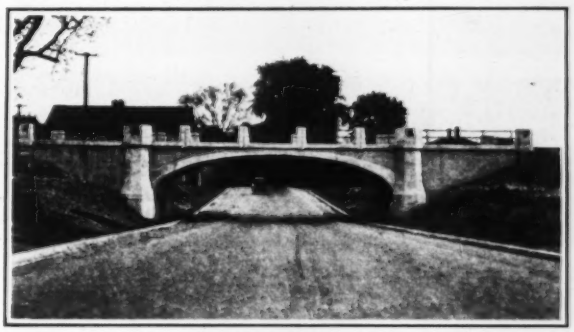


FIG. 2—ARCH CROSSING COMPLETED

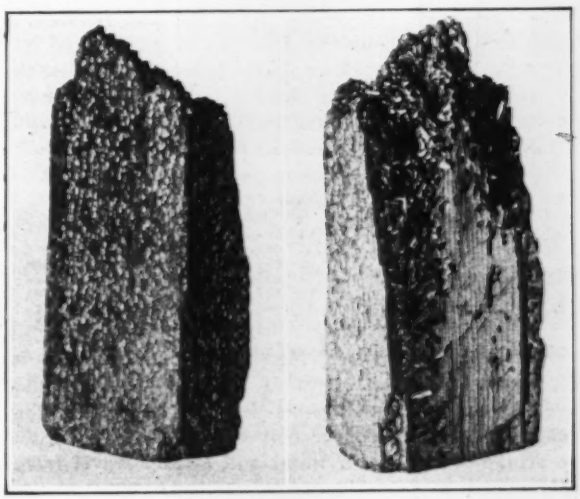
provided for by the A.R.E.A. specifications for steel bridges, and further reducing the impact 20 per cent for each foot of fill, making the impact zero for fills exceeding 5 ft.

Work of Teredo Difficult to Detect

BY EMANUEL FRITZ
Associate Professor of Forestry, University of California, Berkeley, Calif.

DAMAGE which the teredo may do to timber structures when there is little surface indication of damage is well illustrated in the accompanying photographs of a dock timber destroyed by teredos.

The teredo begins his work soon after birth by boring a tiny circular hole, of a diameter scarcely large enough to permit entrance of a pencil point. The worm, once inside, grows rapidly, reaching a full-grown length of



EFFECT OF TEREDO ON DOCK STRUCTURE
Left shows timber surface; right, interior. Light spots are discoloration left after barnacles were scraped off. Small black dots are entrance holes of teredo.

around 20 in., and a diameter of about $\frac{3}{8}$ in. Because of this it is difficult to judge the interior damage by superficial exterior examination. In that way they are not like limnoria, which reduce the timber in size so that the engineer can at all times see how much the structure is being weakened.

Cantilever Highway Bridge Across Carquinez Strait

3,350-Ft. Structure with Two 1,100-Ft. Main Spans and Two 500-Ft. Anchor Spans—Design Selected Has Marked Advantage Over Suspension Type—Cost To Be Met by Tolls

By C. Derleth, Jr.
Chief Engineer, American Toll Bridge Co., San Francisco

ONE of the longest and most substantial highway bridges yet built is now being constructed across Carquinez Strait in California at a strategic location with respect to Mare Island Navy Yard and at the same time in the path of established lines of travel between the San Francisco Bay region and the northwest and central parts of the state. The company organized to build this bridge grew out of the Rodeo-Vallejo Ferry Co. whose service the bridge will supplant. The crossing is at the west end of Carquinez Strait, as shown in Fig. 1, from Valona, Contra Costa County, on the south, to Morrow Cove, Solano County, on the north of the waterway. The bridge proper is 3,350 ft. in length, to which will be joined the viaduct and highway approach at the south, about 1,400 ft. long. The total estimated structural cost is $5,500,000 which is exclusive of rights-of-way, legal and other expenses incidental to the application for franchise and War Department permit. Announcement of financial arrangements and award of substructure contract to the Missouri Valley Bridge & Iron Co., and of the superstructure to the American Bridge Co. appeared in *Engineering News-Record*, June 4, 1925, p. 948.

The plans for the Carquinez Bridge were approved by the state engineer of California Feb. 1, 1923, the franchise was granted by the Contra Costa County supervisors Feb. 5, 1923, and the War Department permit was issued April 17, 1923. Work on the bridge has been in progress since April 2, 1923.

Traffic—The bridge income will be derived from tolls whose rates per vehicle are fixed by the franchise. These rates are about the same as those charged by the Rodeo-Vallejo Ferry Co. The following table gives the operating revenue for the Rodeo-Vallejo and "Six-Minute" ferries and the number of passengers and vehicles carried since these ferries were established:

OPERATING REVENUE FROM FERRIES

Dates	Operating Revenue	Passengers	Vehicles
July 1-Dec. 31, 1918.....	$39,360.38	98,400	31,488
Jan. 1-Dec. 31, 1919.....	170,601.45	404,399	130,586
Jan. 1-Dec. 31, 1920.....	324,694.73	1,061,012	350,884
Jan. 1-Dec. 31, 1921.....	410,198.24	1,242,539	399,768
Jan. 1-Dec. 31, 1922.....	398,129.39	923,476	334,601
Jan. 1-Dec. 31, 1923.....	468,166.81	1,221,037	412,689
Jan. 1-Dec. 31, 1924.....	514,589.53	1,207,235	463,617

When the Carquinez Bridge has been completed it will invite traffic in addition to that which would have passed over the Rodeo-Vallejo ferry because the greater convenience of transit without delays across the bridge either day or night will attract travel from other routes.

At present on week-ends and holidays when traffic becomes greatly congested many prefer to go from Sacramento points to Oakland and San Francisco via Stockton avoiding the passage over Carquinez Strait. But this route is about 30 miles longer than the direct highway from Sacramento to San Francisco via Carquinez Strait. Again, considerable traffic from Marin County and the north which now reaches San Francisco by ferries will be attracted to the Carquinez Bridge.

Extended studies to predict probable future traffic over the bridge and probable income to be derived were made in 1923. They were based upon the actual records of the Rodeo-Vallejo and other ferries in combination with estimates of probable increase in automobile registration and population in the state. From them a

FIG. 1—SEVEN PROPOSED BRIDGE LOCATIONS, SAN FRANCISCO BAY
Carquinez Strait Bridge at site No. 6

probable rate of traffic increase was established. The predicted traffic for 1924 compared with the actual figures is:

	Vehicles Carried	Gross Income
Predicted	454,000	$508,000
Actual	463,617	514,000

Judging from precedents the bridge should also develop a large amount of new traffic. Just how much this will be it is difficult to estimate. After studying all available data it was concluded that the bridge traffic would exceed the ferry traffic by 25 per cent and that this increase would extend over a period of three years beginning with the opening of the bridge. After this three-year period it was assumed that traffic would increase at the normal predicted rate.

The estimates for future traffic were made purposely on a most conservative basis. They indicate that at the expiration of the franchise in the year 1948 the income from tolls will be very substantial. The Carquinez Bridge is conservatively estimated to cost $6,000,000. The project therefore is a very sound and favorable investment judging from traffic studies and income possibilities.

The California State Highway Department has in contemplation a program for a large amount of new

highway construction and of improvement, widening and re-alignment of present trunk highways contiguous to the Carquinez Bridge. This must definitely increase the volume of traffic over the bridge, even if the program is restricted solely to the widening and straightening of the main trunk highway between San Francisco points and Sacramento.

Design Considerations—The plans on which the bridge is being built provide for two 500-ft. anchor spans, two main spans of 1,100 ft. each, a 150-ft. central-tower span, and 1,132 ft. of steel viaduct approach at the south end, as shown in Fig. 2.

The first designs contemplated a stiffened suspension bridge with a central span 1,600 ft. and equal side spans 800 ft. each. This design placed the south tower pier in the deep waters of the strait 400 ft. north of the south pierhead line. In the hearings before the Contra Costa supervisors upon application for franchise strong objection was made by navigation interests to the location of this pier. Finally the supervisors announced that they would vote a franchise to the Rodeo-Vallejo Ferry Co. provided a plan was submitted in which a major pier would be located just inside the south pierhead line and with no pier to the north nearer to that pierhead line than 1,000 ft. This requirement obliged the ferry company to prepare a plan for a suspension bridge in which the central span was increased to 1,950 ft. The condition also allowed a cantilever bridge plan with two major spans of 1,100 ft. and a tower pier in the center of the strait.

A comparative study of the two types proved the cantilever to have predominant advantages and both cantilever and suspension plans were submitted to the War Department with the request that the cantilever plan be approved. The major reasons why the cantilever bridge was considered more desirable are: (1) The end anchor piers for the suspension bridge are much more costly than the end piers for the cantilever anchor arms. (2) The suspension bridge anchor piers are much more bulky. This is particularly important at the south terminal where a huge anchor pier would interfere with the proposed freight yard development of the Southern Pacific R.R. (3) Anchor piers for the cantilever bridge carry only vertical loads. The suspension bridge anchorages each must withstand a total horizontal pull exceeding 23,000,000 lb. applied more than 130 ft. above the high water level. (4) The total length of the main suspension bridge is 3,900 ft.; for the cantilever this length is only 3,350 ft.. In the cantilever design therefore about 500 lin.ft. of major structure is replaced by a less expensive approach viaduct. (5) At the south bridge terminal the greater viaduct length for the cantilever design gives greater elasticity for alignment and lesser grades to the state highway. (6) The main suspension bridge rests on two tower piers while the main cantilever bridge rests on three piers. The total loads on foundation beds therefore are greater for the deep piers in the suspension bridge design. (7) The cantilever bridge is a stiffer construction, less flexible against lateral forces. To make the suspension design equally stiff would add greatly to the estimated costs. (8) The long span suspension bridge requires towers rising higher than those for the cantilever bridge. The lower tower height is to be desired should the structure be subject to earthquake vibration. (9) To provide for additional traffic in later years the cantilever bridge can be more readily and economically reinforced. (10) For equal stiffness the suspension bridge would cost at least $2,000,000 more than the cantilever. (11) The cantilever structure has the marked advantage of full static determination of stresses in all of its members, which contributes to material economy in design. Although well-known methods of analysis overcome to a sufficient extent for all practical purposes the indetermination of stresses in the stiffened suspension bridge, there is not the same degree of satisfactory determination as in the cantilever. (12) The erection of a cantilever structure is simpler and more expeditious than the erection of a stiffened suspension bridge, reducing cost and saving time for the erection of the former, thus enabling the structure to reach the earning stage in materially less time than the latter. (13) There are at times high winds at the strait which frequently may blow at right angles to the bridge axis. While it is feasible to provide for this horizontal wind load with either type of structure, it is much simpler and more economical to provide the necessary wind

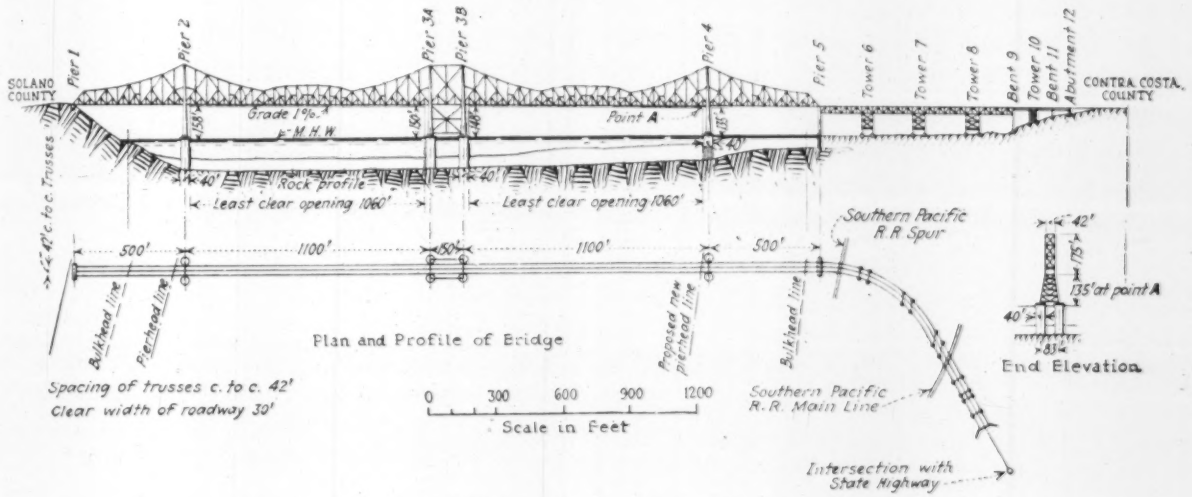


FIG. 2—PLAN AND ELEVATION OF CARQUINEZ STRAIT BRIDGE

braces with a cantilever plan and with a much higher degree of stiffness. It seems highly probable that in the near future this bridge may be obliged to provide for trolley traffic. The stiff inflexible character of the cantilever truss is admirably adapted to such properties while the flexible character of the stiffened suspension bridge is not so well adapted for high-speed trolley traffic.

Loads and Design—The bridge was designed for motor truck, electric car, and sidewalk loading. A conventional 20-ton motor truck was specified to occupy an area 10 ft. wide by 32 ft. long with wheel concentrations of 6,000 lb. on each front wheel and 14,000 lb. on each rear wheel; wheel spaces 6 ft. centers and front and rear axles placed 12 ft. centers. The number of trucks per traffic lane was limited to three, to be followed by a uniform load of 600 lb. per lineal foot.

The electric car loading consists of a train of six 96,000-lb. cars, standard gage, each car 60 ft. long, with wheel concentrations 12,000 lb. each, spaced 6 ft. 6 in. centers of axles in one truck and 33 ft. 6 in. centers of trucks. In the computations the car loading was considered to displace an equal length of one line of motor trucks and uniform load.

The sidewalk loading consists of a uniformly distributed load of 50 lb. per square foot.

Fig. 4 gives the typical cross-section for the bridge. Trusses are spaced 42 ft. centers providing a 30-ft. clear roadway with two 4-ft. 3-in. sidewalks. The trolley track is in the center of the roadway.

For the design of floor system and hangers a train of 96,000-lb. cars each 60 ft. long as above was used, while for the trusses and piers a trainload of 1,600 lb. per lin.ft., 500 ft. long, was specified. Train weights upon the bridge are limited to a total weight of 800,000 lb. The highway loading for the floor system and hangers consists of 20-ton trucks in three lines without railway, or two lines with railway.

The higher portions of the steel viaduct forming the south approach to the main bridge cross the properties of the Southern Pacific R.R. Towers 6, 7, 8 of the viaduct are upon the railroad lands. Their bent spacing is 45 ft. The four main spans of the curved viaduct range in lengths from 191 ft. to 175 ft.. The railroad requirements forced the towers to be on skew as shown in Fig. 2.

The superstructure was designed mainly of carbon steel for the anchor arms, floor system and viaduct, and of silicon steel for the trusses of the suspended spans, cantilever arms, central tower span and the three main

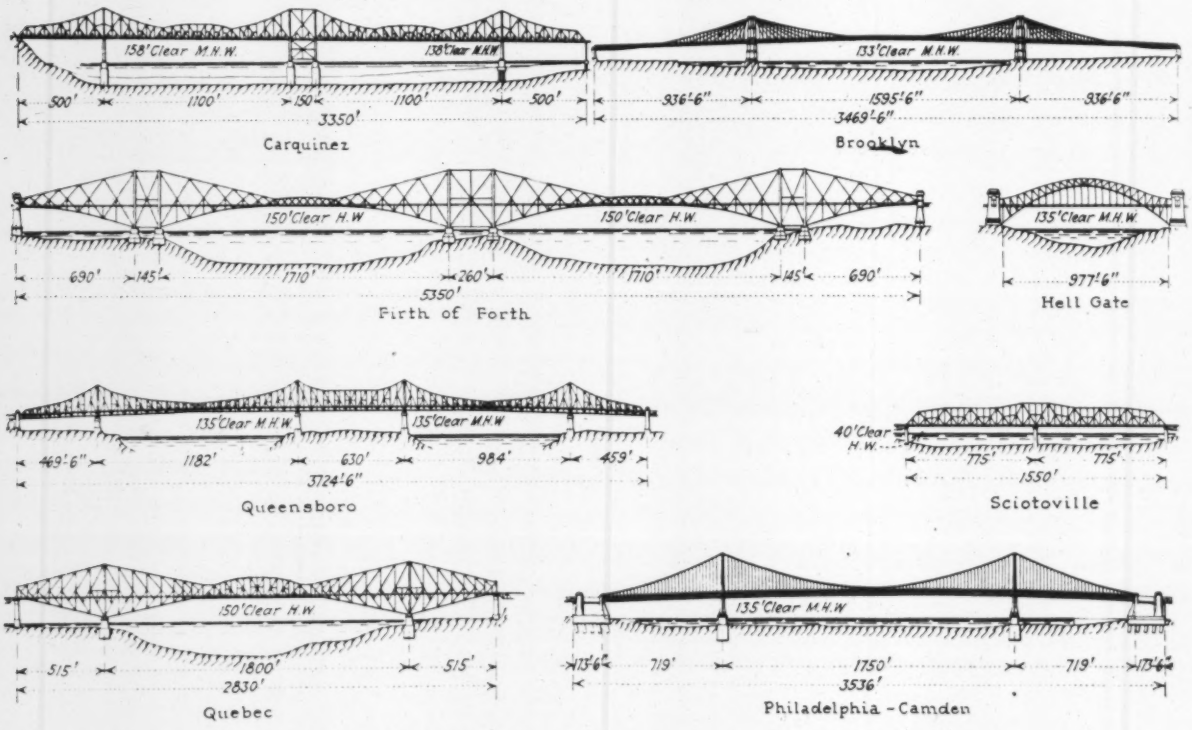


FIG. 3—COMPARATIVE ELEVATIONS OF THE LONG-SPAN BRIDGES OF THE WORLD

towers at piers 2, 3, 4, except for the large eyebars in trusses which will be made of heat-treated carbon steel.

The total estimated steel weights are: Carbon steel 10,900 tons; silicon steel, 3,020 tons; heat-treated eyebars of carbon steel, 1,405 tons; cast steel, 65 tons; total 15,390 tons. Additional studies now in progress for the superstructure design indicate that in the preparation of the shop drawings there may be included a more extensive use of silicon steel members to save dead-load and freight.

In the original design the two balanced suspended spans were calculated for erection as cantilever arms. The final design may be modified to substitute the flotation method of erection for the suspended spans and the sub-floor portion of the 150-ft. tower span. If such a change in erection program is made it may involve a shorter suspended span and correspondingly longer cantilever arms.

The highway floor slab is of reinforced concrete 7 in.

thick with transverse expansion joints at each floor-beam.

Foundations—The north anchor pier, No. 1, and the viaduct piers on the south hillside, No. 9, 10, 11, 12, are simple foundation footings, pier 1 resting on sandstone and the others on shale rock. In all of these piers the rock comes practically to the surface. The viaduct piers under towers 6, 7, 8 and the south anchor pier of the main bridge are also quite shallow and in all cases rest on timber piles.

Piers 2, 3, 4 comprise the difficult foundation work. Pier 4 consists of two reinforced-concrete shafts each 40 ft. square spaced 83 ft. centers transversely, which shafts rest upon a slab of reinforced concrete. This slab is about 28 ft. thick, of rectangular plan 43x139 ft. The top of the slab is at elevation —22 ft. below mean high water. The lowest 14 ft. have been placed as

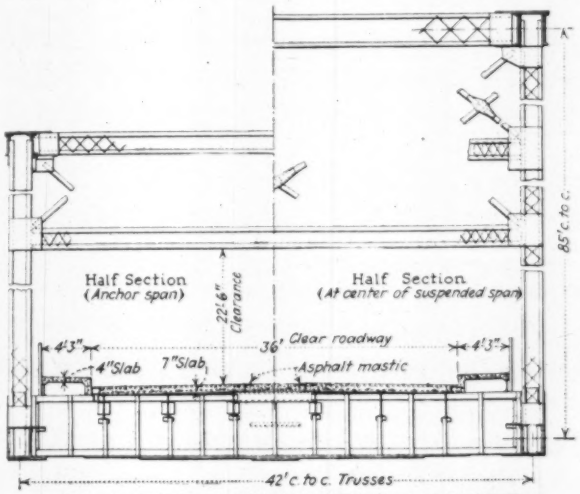


FIG. 4—TYPICAL CROSS-SECTION, CARQUINEZ STRAIT BRIDGE

tremie concrete under water within a huge timber cofferdam whose cutting edge is at elevation —51 ft. The cofferdam has been successfully placed. Its outer dimensions are 52 ft. 4 in. by 147 ft. 4 in. and 55 ft. high from cutting edge to top braces.

Later articles will be published describing this work at pier 4 and also the foundation, design and construction at piers 2 and 3. For this reason details are not now given. The same applies to the stuperstructure steel design.

The foundations at piers 2 and 3 are the most distinctive features of the Carquinez Bridge and involve difficult and to some extent unprecedented problems. At pier 2 the foundation consists of two shafts each 40 ft. square in plan and 83 ft. centers transversely. At the central tower pier the foundation consists of four of these shafts spaced 83 ft. centers transversely, and 150 ft. longitudinally.

All six shafts are 40 ft. square and are constructed of timber framed to provide four dredging wells 8 ft. square. The framing is arranged to provide flotation chambers which will be filled with reinforced concrete as the structure sinks, thus forming masonry walls around and between the four chambers, each wall being about 7 ft. thick. Eventually the dredging chambers will be sealed and filled with concrete.

At the site of these piers the water depth is about 85 ft. and the depth below mean high water to sandstone rock is 135 to 140 ft. Material from the bottom of the strait to rock through which these cribs must be sunk by dredging consists mainly of a mixture of sand with some clay, the sand particles growing coarser with the depth.

The pier tops will be at elevation +10 ft. so that each shaft may have a total vertical dimension of 150 ft. from pier top to foundation bed.

The total vertical loads upon the foundations of piers 2 and 3, including wind and current transfer, but with no deduction for buoyancy, give pressures on bedrock ranging from 14 to 16 tons per sq.ft. Allowing for buoyancy these are reduced to 10 and 12 tons. Deducting also the displaced materials, the disturbing pressures in excess of the native or original load amount to 9 to 11 tons per sq.ft.

Since Carquinez Strait is subject to considerable stormy weather and tidal currents may reach a velocity of 6 to 7 ft. per sec., the first cribs at pier 3 are being sunk within a guide frame securely anchored. Experience may prove that this precaution is unnecessary.

Originally three alternate plans for piers 2 and 3 were studied and developed. In the first design each pier cylinder consisted of an outside steel shell 40 ft. in diameter with an inside steel shell 20 ft. in diameter forming a single dredging chamber. In most respects the design was similar to that of the East Omaha bridge pier described in *Engineering News*, Vol. 30, p. 410 and *Engineering Record*, Vol. 30, p. 218; but required heavier steel bracing between the shells. The second design was of reinforced concrete with five dredging wells. The timber crib just described was the third type.

The first two schemes in steel and concrete on account of their greater weight and less capability of flotation required bulkheads in the dredging wells until the structures reached a firm landing on the straight bottom. The timber crib type was finally selected for two sufficient reasons; less cost and less hazard.

The American Toll Bridge Co. has direct charge of the project with Aven J. Hanford, president; O. H. Klatt, vice-president; C. Derleth, Jr., chief engineer; William H. Burr, consulting engineer; D. B. Steinman, designing engineer; George J. Calder, resident engineer.

Rack-Rail System for Light Railroads

A new type of rack-rail traction, intended specially for steep-grade light railroads, has the rack formed on the outer side of a rail head in which the sides have a wide flare, with an included angle of 42 deg. The vertical teeth or corrugations are only ¼ in. deep, with a pitch of 1¾ in. In addition to the ordinary adhesion driving wheels, the locomotive has a pair of grooved wheels which are driven by gearing from independent cylinders and can be lowered so as to engage the rail head. The outer face of the groove, which is notched to fit the shallow teeth of the rack, consists of a ring bolted to the main part of the wheel, so that it can be removed for repair or renewal. It is reported that in tests on a grade of about 8 per cent on a track of 30-in. gage laid with 25-lb. rack rails, a 7½-ton tank locomotive stalled with a load of about 20 tons; but when the grooved cog wheels were engaged with the rack rail the load was taken up easily. This new rack-rail system is being introduced by the Rail-Grip Syndicate, 2 Gresham Buildings, London, England.

Highway Parallels Hudson River Along Top of Palisades

Road Structures Harmonize with Surroundings on $100,000-a-Mile Highway—Mixer Batches Hauled 13 Miles

CONSTRUCTION of a scenic highway along the crest of the Palisades of the Hudson River by New Jersey and New York co-operating is now in active progress on the New Jersey portion. Officially the operation is known as Route 18-North of the New Jersey state highway system and involves the demolition of a worn-out waterbound macadam road, preparation of subgrade, considerable rectification of alignment, the placing of 10 miles of reinforced-concrete slab, the widening of two large concrete culverts, and the erection of the other road structures. The complete project calls for a road from West Hoboken to the New York line, although the work in immediate prospect runs from a point 1½ miles east of Englewood, N. J., north to the state line. New York's plan is to project its highway south from Nyack (Fig. 1) to connect with the New Jersey highway. It is expected that work on the New York end will be started early next year. The existing road in New

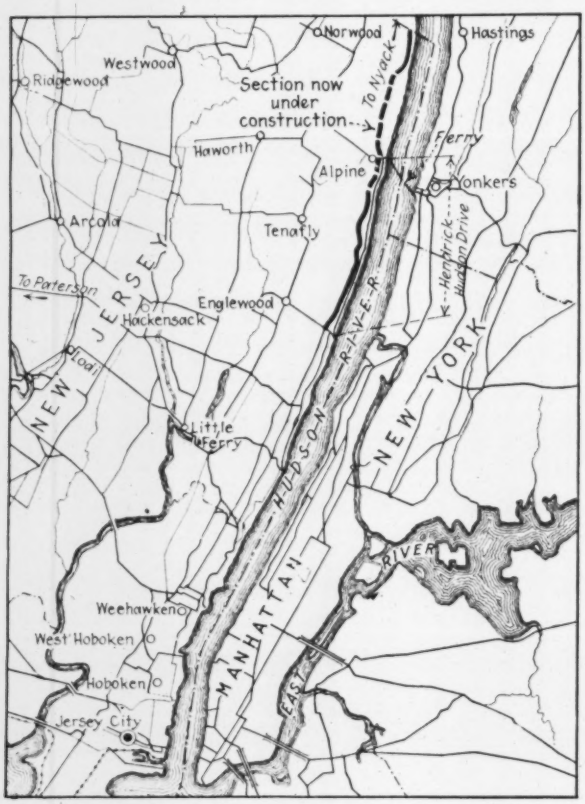


FIG. 1—SKETCH MAP SHOWING LOCATION OF PALISADES ROAD

Jersey has been little used, the adjoining property being in the form of large estates. Commercial possibilities for the new road will no doubt develop, but it is essentially a scenic drive.

The section now under construction starts 4.3 miles from the Englewood end of the route and runs about 3¼ miles north, ending 1½ miles from the state line. Work was started May 21, 1925, to be completed in 130

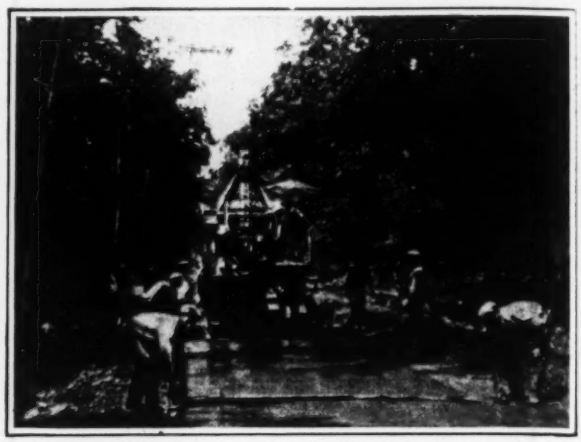


FIG. 2—FINISHING OPERATIONS ON HALF-WIDTH PAVEMENT

Next to the mixer may be seen the strike-off board; in the center is the tamping board weighing 20 lb. per foot. The type of belt used is shown in the foreground. Transverse brooming completes the finishing operations.

working days. The contract price is approximately $100,000 per mile, financed wholly by the state. The new road is located on top of the famous Palisades of the Hudson, more than 400 ft. above the scenic Hendrick Hudson drive, running along the base of the cliff near the river-level. This latter drive winds up the cliff from the Yonkers, N. Y., ferry to meet the new highway at Alpine. Although the section now under construction is several hundred yards west of the river, the final 1½ miles of the route will run along the extreme edge of the cliff; it will be protected by masonry parapet walls.

The New Jersey State Highway Commission's standard designs for the slab and the road structures are used throughout. The slab is 8 in. thick, 20 ft. wide on grades up to 4 per cent, of a 1:1¾:3½ mix and is reinforced with a double system of deformed bars ¾ in. in diameter. On grades of 4 per cent and over a 30-ft. paved width with curbing is constructed. Cable or wood guard rails are used on all embankments over 3 ft. high. Articles describing the New Jersey Highway Commission's standard designs and practices appeared in *Engineering News-Record*, July 9, 1925, p. 48, and July 30, 1925, p. 176.

Construction Methods and Procedure—The preparation of the subgrade will necessitate 6,700 cu.yd. of earth excavation, 7,800 cu.yd. of rock excavation, and the placing of 10,500 cu.yd. of borrow material. The latter is very porous, consisting largely of sand and gravel, and provides excellent drainage for the shoulders where the major portion of it is used. The contractor operates a borrow pit located about ½ mile from the line of the highway and almost directly opposite the mid-point of his section. A great deal of line rectification is being done, although none of it is of special magnitude. The maximum grade is 7 per cent and all curves are banked approximately 2 in. per degree of curvature. Curves are kept below a maximum of 6 deg.

All cut work involves the blasting of hard granite rock. The spoil material is used for fill and covered with borrow for the immediate sub-base. The graded width is 30 ft. in all cases, a further 2-ft. shoulder being provided where the curb is used.

The slab is placed in half widths so that at all times one side is open for traffic and the contractor's operations. Traffic has been of practically no concern so that

the mixer and material trucks have been able to operate on the side that is not under construction; thus, the subgrade can be kept in a smooth, rolled condition for receiving the concrete. Furthermore, there is more assurance that the side forms will remain in alignment than if the sub-base is used for construction operations. The total amount of slab to be placed is 43,500 sq.yd.

Sand and 1½-in. trap-rock aggregate are purchased from a supply company that uses its own trucks to deliver the material to the mixer. The haul averages about 13 miles from the dock plant of the company to the site of construction operations. A truck holds four batches of 21 cu.ft. of rock and 11½ cu.ft. of sand. The latter contains a 10 per cent excess arbitrarily fixed over volume requirements so as to take care of variable moisture content. A 6-bag batch is used. Pre-molded asphaltic-compound expansion joints ½ in. thick are placed on the center line and transversely on 45-ft. centers.

Double-mat reinforcement in sections 12 ft. long by 9 ft. 6 in. wide is used throughout, the two planes of bars being held 4 in. apart by separators. The mats are fabricated on a rack frame made of steel angles and flats properly punched and slotted for the required spacing of the reinforcing bars. Before placing the reinforcement in the slab, a 2-in. layer of concrete is spread on the subgrade; the reinforcing mat is then placed upon this layer of concrete and the rest of the slab immediately poured. Adjacent reinforcing mats are lapped about 12 in.

Construction joints are made with ¾-in. diameter dowel pins 30 in. long, one end of which is wrapped with tar paper to prevent bond; the other end is allowed to remain fixed in the slab. Three of these pins are used for a half-width slab. Curbing, aggregating 5,000 lin.ft., is being poured in 10-ft. sections. These sections are separated by steel header plates which when removed leave a ¼-in. open-cut joint.

Road Structures—All bridges and culverts have been designed to harmonize with their surroundings. The road traverses rather dense woods in which outcropings of dark brown granite rock are very common. All headwalls of bridges and culverts are constructed of dry or cement rubble made from this outcropping rock. Most of the culverts are small and cast-iron pipe is used for the waterway. However, two bridges with 20-ft. dry-rubble headwalls have so far been completed. In both of these cases construction consisted in widening existing reinforced-concrete structures. One railing wall of the old culvert was cut off flush with the floor and a new dry rubble wall constructed outside of this. The opposite side of the culvert was then faced with dry rubble to match. No changes in waterway capacities have been necessary. Plans call for a granite cap piece on all head walls, although in one instance thin rocks have been set on edge to form a jagged surface similar to an adjacent property fence.

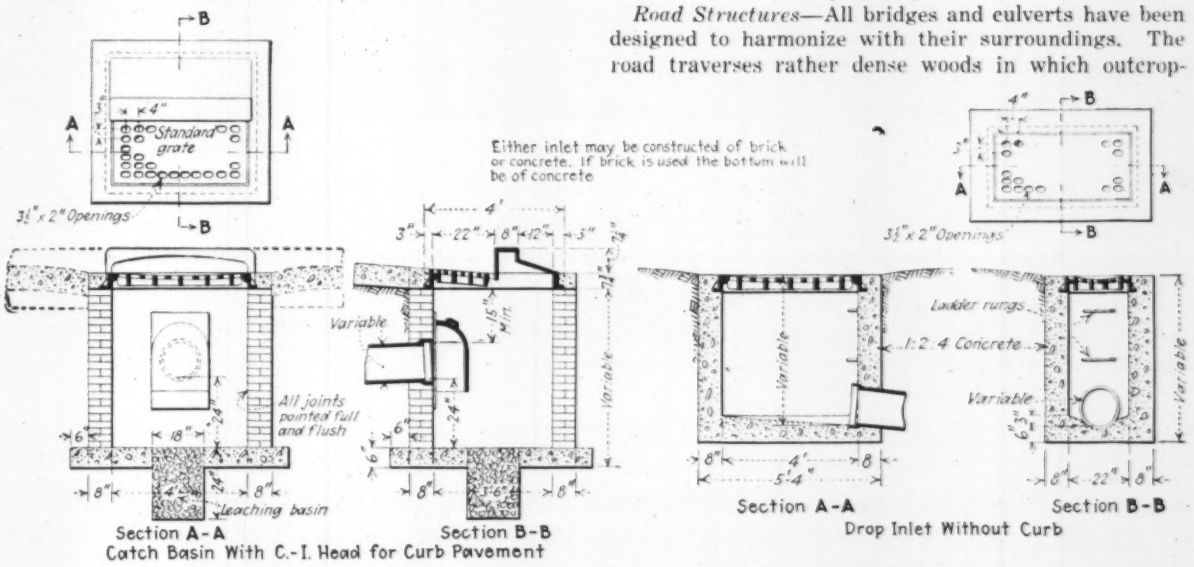

Either inlet may be constructed of brick or concrete. If brick is used the bottom will be of concrete
Standard grate
3½"x 2" Openings
All joints pointed full and flush
Leaching basin
Variable
Section A-A
Catch Basin With C.-I. Head for Curb Pavement
Section B-B
Ladder rungs
1:2:4 Concrete
Section A-A
Drop Inlet Without Curb
Section B-B

FIG. 4—STANDARD STORM WATER STRUCTURES FOR NEW JERSEY HIGHWAYS

FIG. 3—INTERSECTION WITH HENDRICK HUDSON DRIVE
The grade in the background is being reduced to 7 per cent. The culvert upon which the cars are standing is an existing reinforced-concrete culvert widened and rebuilt with 20-ft. dry rubble head walls to harmonize with the surroundings.

Finishing—Special efforts are being made to secure a surface absolutely free from transverse wave. The first operation, after pouring, is to use a 12-ft. strike-off board made up of two 2x6-in. boards nailed together. Following this, a 12-ft. screed or tamping board 8x8 in. in section and weighing 20 lb. per foot is used until the surface is smooth as determined by repeated and careful use of a straightedge. On an average, the struck-off pavement must be gone over three times in order to secure a satisfactory surface. Four men are required to operate the screed. After belting, the final finish is secured by transverse brooming with ordinary street brooms.

Curing is effected by using 4-ft. strips of wetted burlap until the pavement sets enough to hold straw. The

curing period is 10 days; if necessary, the road is opened to traffic after 14 days.

Personnel—The work is being carried out under the direction of the New Jersey State Highway Commission, L. E. Andrews, division construction engineer. S. W. Maulbeck is resident engineer for the commission, and John J. McGarry, Edgewater, N. J., is the contractor.

Test Program for Arch Dam Investigation

A STATEMENT of the tests and measurements to be made on the experimental arch dam now being built in California for a research committee of Engineering Foundation has just been prepared by the committee (chairman, Prof. Charles Derleth, Berkeley; secretary, F. A. Noetzli, Los Angeles). The following summary of the program supplements the description of the test dam and the manner of designing it given in our May 14 issue, p. 816. It will be recalled from that description that the dam is to be built at first 60 and later 100 ft. high; that it will be of extreme thin-arch type, though designed by the combined-arch-and-cantilever method of analysis; that the upstream face, which is vertical, will have a radius of 100 ft., and that the thickness of the dam is to be 2 ft. from the crest down to a point 30 ft. above the base, whence the thickness will increase by a gradual curved batter of the downstream face to a base thickness of 7½ ft.

General Purpose of Test—The dam is being built to give precise information, on working scale, concerning the stresses, movements and changes of volume of thin arch dams, the theory of which is not in completely satisfactory condition. According to the design calculations, the maximum vertical tension in the dam occurs 5 ft. above the base and is 400 lb. per sq.in., while the maximum vertical compression is 455 lb. per sq.in.; the corresponding figures for horizontal stresses (arch action) are 341 lb. tension (extrados, near abutment, 20 ft. above base) and 915 lb. compression (intrados, near abutment, 27 ft. above base). Cracks may develop from these tensile stresses.

The experiment is expected to supply partial answer to some or all of the following points of question: (1) As to stresses: division of the water pressure between the different resisting elements; arching in inclined planes, and secondary arching in interior of thick arches; horizontal stress variation between crown and abutment of arch elements; applicability of common theory of flexure to thick triangular cantilevers; shear deformation in cantilever beams. (2) As to temperature and distortion effects: variation in temperature change from upstream to downstream face; relation between temperatures of air, water and concrete; shrinkage due to setting; swelling due to moisture; flow of concrete under sustained load; effect of lateral deformation; yielding of foundation and abutments. (3) As to construction influences: effect of vertical construction joints or cracks; effect of horizontal cracks on cantilever action; effect of water pressure in horizontal cracks or construction joints; importance of uniformity of concrete, arrangement and preparation of construction joints, and difference of age between successive horizontal sections.

Laboratory tests bearing on a number of these points will be carried on at the same time as the measurements on the dam.

Measurements on Dam—Strains, deflections and temperature changes will be measured at as many points as practicable, under a variety of load and temperature conditions and with sufficient repetition to assure well checked results.

Strains on the exposed downstream face will be measured by a direct-reading device such as the Berry strain gage, while strains in the interior of the concrete and on the upstream face will be measured by the carbon-resistor strain gage developed by McCollum and Peters at the Bureau of Standards. The tentative layout of strain-gage locations provides for measurement at eight different levels and at five different points along the length of the dam at each level. On the downstream face 12 strain-gage readings are to be taken, at each point, along the peripheral and radial lines of a hexagon. On the upstream face and at mid-thickness of the dam, in general three gages and a resistance thermometer will be built into the concrete at each point, so as to give a reading downstream, longitudinally, and vertically, and a temperature reading. These instruments are to be read electrically at a station adjacent to the dam.

Deflections will be measured at three meridians of the dam, from protected steel towers, whose movements (if any) will be measured by transit sights. Near the foundation the deflections will be measured by strain-gages applied between the dam and one of the towers, while at higher elevations deflections will be recorded graphically. Clinometer measurements will be made by sensitive level bubbles, between bolts fixed in the downstream face of the dam, to furnish a check on the deflections. Occasional measurements of vertical elevations and profile surveys will be made as a check on unlooked-for movements.

In general, it is expected that measurements will be repeated at 30 to 60-day intervals during a year, to determine and eliminate the influence of seasonal temperature variations. For determination of plastic "flow" of the concrete, water in the reservoir will be allowed to rise at such a rate as to fill the reservoir within one or two weeks, then will be kept at crest level for a month or more. An opposite process will be followed in determining the influence of moisture changes in the concrete, the reservoir being emptied and held empty for a definite time to permit the concrete to dry out.

Henry Hawgood, consulting engineer, Los Angeles, is chairman of the subcommittee on test dam of the general research committee on arch dam investigations. Comments or suggestions bearing on the test program are invited; they may be addressed to Mr. Hawgood or to A. D. Flinn, director of Engineering Foundation, 29 West 39th St., New York City.

Magnetic Observatory in West Greenland

A magnetic observatory will be established at Godhavn on the Disco Island, West Greenland, in accordance with the recommendation expressed in a resolution adopted at the meeting of the International Geodetic and Geophysical Union in Madrid in October, 1924, the Department of Commerce is advised from Copenhagen. It is stated that this observatory will fill one of the greatest gaps in the net of magnetic observatories which now spans the world.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

BOULEVARD, SANTA MONICA, CALIF.

Santa Monica, Calif.

FOUNDED IN 1875 by U. S. Senator Jones. Was part of a sheep range of the Rancho San Vicente y Santa Monica. Location is striking and beautiful, in Los Angeles County sixteen miles west of Los Angeles. The city is on a high bench ending in abrupt Palisades 50 to 150 feet high, above the Pacific Ocean, and is surrounded at a little distance by mountains. It is mainly a resort city, entertaining millions of people annually, but within the city limits is a large deposit of clay from which go large shipments used in making the highest quality of brick. Pop. 40,000.

"ENGINEERING problems? We don't have any," declared City Engineer Howard B. Carter, of Santa Monica, Calif. "Our problems were considered and taken care of fifty years ago by the engineer who laid out the town under the direction of Senator Jones, and who was a half century ahead of his time.

"They picked a natural town site on land fairly level and with good drainage. It is on the sea and the surroundings are beautiful. The streets run at right angles, and all are 80 ft. wide except two, which were designed for the principal business thoroughfares and are 100 ft. wide, but the plans miscarried a little, as the business heart is two blocks away from them. Apparently Senator Jones thought of everything. There were plenty of parks designated, which are well kept and much appreciated; hotel sites were chosen and city lots well laid out. So engineering is easy."

Despite Mr. Carter's light disposition of the duties of his job, Santa Monica has some interesting engineering problems, which are being solved in frictionless manner.

Government—Santa Monica has the commission form of government, established twelve years ago. It is ruled by three commissioners serving four-year terms, who form the City Council. They give all their time to the work and receive $3,000 a year each. The Commissioner of Public Safety is responsible for the fire, police, health and building departments. The Commissioner of Finance is tax collector, issues all licenses and is also city clerk. The Commissioner of Public Works controls all public buildings, all streets and sewers, the municipal water system, parks and playgrounds. The three commissioners appoint the city attorney and the city engineer, for no stated term, but custom makes it for the four years of the full commission term. The commissioners do not all go out of office at one time—the terms overlap. City Engineer Carter served as chief deputy from 1919 to Dec. 7, 1923, when he was appointed engineer.

Finance—During 1924, the city received a little more than $605,000 in taxes, $48,500 in licenses, $53,000 in departmental receipts, and $13,288 from traffic fines. The total receipts were about $725,000. This is exclusive of water-works funds of $187,594.11, which are used exclusively for the maintenance of the water-works system. The city tax rate is $1.75 per $100 of assessed valuation, which is very low. Because of the many improvements which are made; however, more revenue is needed for the fiscal year 1925-26, and this will be secured by raising the valuation, which is now about 40 cents on the dollar. The total revenue for the fiscal year ending July 1, 1925, is about 10 per cent over that of 1924.

Improvements are inaugurated by petition and are voted by the city council after a day of hearing of protests. In case of public necessity the council inaugurates the work itself. All public works are performed by contract.

The city engineer's force consists of the engineer, eight field men, three draftsmen, and one office man. Costs are low; other engineers come occasionally to find out how they are kept so low; it is due to close supervision, well planned work, fair treatment of all help, well selected men for each particular task, and complete co-operation. The average engineering costs on the last forty jobs, aggregating $1,500,000, were 1.28 per cent. In these costs are included engineers' salaries, supplies, automobile operation, office stationery and clerk hire. For the same period the total incidental costs amounted to 2.93 per cent. These included newspaper advertising, making of warrants for contractors, inspection fees, laboratory tests and transportation charges for all men.

Streets—The streets are generally level. Wilshire and California are the 100-ft. boulevards selected by the founder as principal business streets and, while they missed this destiny, they are important arteries. Wilshire has just been paved for a distance of 10,500 ft. to a width of 75 ft., which is equivalent to eleven miles of 20-ft. roadway. It is also fitted with new ornamental lights.

There is a comprehensive plan of street improvement on foot. Hills are being cut down and sharp turns eliminated. The city of Santa Monica has two business districts—Santa Monica proper, and Ocean Park, which is 2½ miles down the coast. In Ocean Park the streets are narrower, and much widening is being done.

Generally speaking, Santa Monica is better prepared for automobile traffic than the average city. Ocean Boulevard, the favorite drive, which extends many miles along the Pacific, connecting a chain of beach towns, is 125 ft. wide. There are ample parking spaces. On a recent week end, 500,000 visitors drove to and through a twelve-mile stretch along Santa Monica Bay. Twenty-five thousand automobiles, in ten traffic lanes, passed up and down Ocean Ave. in Santa Monica during twelve hours of a holiday.

"Smooth, free streets enable the fire department to

get about more quickly, and so reduce our insurance rates," says Mr. Carter. "Consequently we are removing all obstructions from the streets, all bumps and above-the-surface openings, so that the paving stretches unbroken from curb to curb."

Pavements—Santa Monica favors black pavements with asphaltic base. The natural soil conditions are such that there is an excellent sub-base. The underlying soil is called canyon gravel, and is black gravel mixed with clay; evidently it was once the bottom of the sea. This canyon gravel has almost the consistency of pavement; one 4-in. pavement down fifteen years is in perfect condition. In the northwest section of the city, where the soil is exceptionally hard, 2 in. of bitulithic on the natural sub-base has been in place six years without maintenance.

Pavements are being laid 40 to 80 ft. in width. The roadways have been widened on ten thoroughfares. These combination jobs, at an aggregate cost of $1,740,000, have just been let. They include oil-macadam pavement with concrete gutters; asphaltic concrete with bitulithic surface; asphaltic concrete laid in one course; and several miles of 8 to 12-in. vitrified pipe sewers; cement sidewalks; and water mains.

"I don't believe in tearing up new pavement to make gas, water and sewer connections a year or two later," says Mr. Carter. "So everything goes in before the pavement is laid. The Southern Counties Gas Co. co-operates fully with us. Even in districts where there are no houses, they put down gas mains at our request before the paving, and have several hundred thousand dollars tied up in this construction, on which they will not realize any returns for several years. Because of their fine co-operation, we in turn make things just as easy for them wherever we can. They save us money, and we try to save them money in return."

Buildings—There is a height limit on buildings of 150 ft. Building inspection is in charge of the Commissioner of Public Safety, though the foundations of all large structures are passed on by the city engineer's department.

Water—The sum of $1,000,000 has just been spent on new mains for the municipal system, for distribution to all sections of the city. Fire hydrants have been placed, regardless of the lack of population in some districts. There is no weakest link in the water pipes, since everything, down to the 1½-in. house connection, is of cast iron.

Three new wells have been drilled and three additional pumps installed in a house designed to accommodate three more. Two new reservoirs have been built, one holding 5 m.g. and the other 3½ m.g. A steel tower holds 100,000 gal. There is a 300-ft. head on both reservoirs. There is a storage capacity of 10 m.g. outside the capacity of the mains. The system is fed by twenty wells scattered over the city for a distance of four miles. These are used part time; they range in depth from 200 to 380 ft.

The average daily consumption is 4 m.g., and the present capacity is great enough for 60,000 people. There is plenty of water for future growth. The geological history of the water-bearing strata shows that the Los Angeles River formerly went to the sea on the surface through Port Ballona, just below the city limits. The subterranean stream still follows that course, and the work on new wells frequently brings up twigs and rotten wood. The basin which supplies the town is about six by ten miles in extent, and is replenished by the runoff from the mountains to the north. Chemical analysis shows the water to be excellent, though a little hard.

Maintenance and salaries are charged against the water receipts; all connections to houses are paid for by the property-owners, and this money also goes into the water fund. The charge for water is the same as in other southern California communities, and enables the water-works department to break even.

Lighting—There is no municipal lighting system; power is purchased from the Southern California Edison Co. Handsome ornamental concrete poles are very popular; there are 1,000 of them in the city and more are being put in weekly. The property holders pay for the installations, and the city, one of the few which pays for electrical energy outright from the treasury, furnishes the current. It costs $35,000 a year. As this total grows, however, a change will have to be made in the near future. Either additional lighting money must be raised in the tax rate, or the people will be taxed for direct lighting.

Sewers—Ninety-five per cent of the city is sewered; the balance is in cesspools. The central collection basin is at Colorado Ave. and the ocean front. The sewage is screened and chlorinated there, and 70 per cent runs by gravity into the ocean, via the municipal pier. The outfall is 1,600 ft. from shore. The other 30 per cent, from sewers serving the ocean-front district, is pumped up through screens. Though the city was among the first to treat sewage electrolytically, that plant has been abandoned. Santa Monica is contemplating joining with Los Angeles and other Bay towns in an elaborate new sewage-disposal plan which will eliminate all but one outfall.

While the city has never suffered serious loss from the runoff of storm-water after a heavy rain, there is enough inconvenience attendant upon the runoff to make improved methods of handling it desirable. A plan is on foot, to be put into operation probably before the next rainy season, to handle the storm-water in conjunction with the city of Los Angeles. Mr. Carter is at work upon the plans.

The runoff for the territory within the city limits is 500 sec.-ft., based on a 1-in. rainfall per hour for thirty minutes. In addition, the city's storm drains must take care of approximately 2,700 acres of the city of Los Angeles, comprising the runoff from the mountainous district adjoining the city limits. These waters enter Santa Monica at the northeasterly limits, and total 840 sec.-ft.

The system which Mr. Carter is designing, in conjunction with the Los Angeles engineering department, contemplates an expenditure of $300,000 minimum, and $700,000 maximum. If only Santa Monica storm-water is handled by it, the cost will be the lower figure. If the Los Angeles authorities decide it is less expensive to have Santa Monica handle the runoff from the 2,700 acres, the enlarged system will cost the maximum figure.

If the joint system is built the Los Angeles territory will be assessed for its share of the burden under the State Boundary Line Act. If Los Angeles takes care of its own runoff, its system will cost at least $400,000, and perhaps more. The main storm drain will be 20,000

Of the Small City

ft. long and 9 ft. in diameter. The material will be reinforced-concrete of monolithic construction, poured in place. There will be between 5,000 and 6,000 ft. of laterals from 24 to 36 in. in diameter. Bonds for the improvement were authorized Aug. 14. They will be sold about Dec. 1.

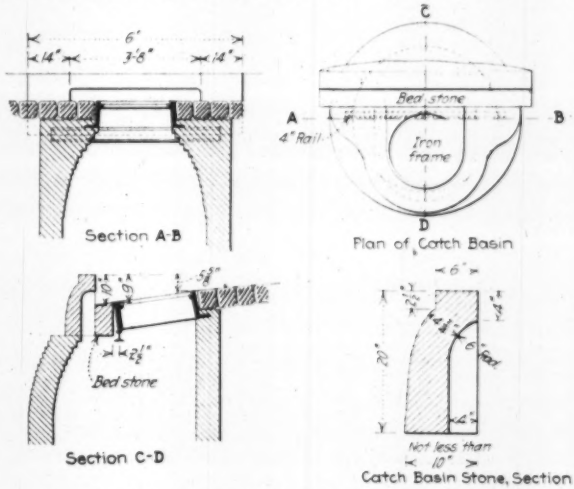
From all appearances, Santa Monica's governing plan with the present commissioners and engineer, is an excellent one. There are harmony and efficiency and a progressive spirit in the city. A very liberal advertising campaign to set the advantages of Santa Monica before the world as a residential town is bringing in many new people, and heightening civic pride and spirit.

The good results in Mr. Carter's department are due to his ability and flair for organization, and also because he demands and receives good work from his subordinates. "We haven't any pensioners," he says; "every man must earn his pay. But when we get hold of a good man we hang on to him, make inducements for him to stay. Our labor turn-over is very small."

Catchbasin Has Protected Curb Opening

ONE is often disturbed, in visiting various cities, by the unsightliness of manhole covers for various subsurface installations, and by catchbasins for surface runoff. Where numerous manholes must appear in the streets, it is obvious that the appearance of the street will be greatly improved if catchbasins combine both sightliness and utility. This is true of the standard catchbasin used in Portland, Me. It is difficult to discover the location of one of these catchbasins unless within a few feet of it.

As shown in the accompanying sketch, the inlet to the catchbasin is through a recess in a granite block set at the line and grade of the curb. Each stone must be



DETAILS OF CATCHBASIN IN USE IN PORTLAND, ME.

of first quality granite 6 in. wide on top, 4 ft. long, and of a uniform depth of not less than 20 in. The block must be straight lined and free from bunches or depressions. It is peen-hammered on top and 2½ in. down on the sidewalk side. The street side is squared with the top and pointed down to its entire depth. Four inches down from the top on the street side the stone is cut out on a radius of 6 in. to a depth of 4 in. from the face. This gives a recess 20 in. wide and 4 in. deep.

With this stone set the catchbasin wall is bricked up with several courses staggered to make the inside of the last course align with the recess space of the granite block. A granite bed stone, 6 x 11 in. x 6 ft., is so placed that its face near the curb is in the same vertical plane as the upper street face of the inlet block. The bed stone then becomes the stone gutter and the inlet to the collection basin is an opening, almost entirely hidden, 6 x 20 in. in elevation and with a maximum depth of 4 in.

Decimal System for Engineering Data

BY JACOB FELD
Civil Engineer, New York City

THE Dewey decimal system of classification, in use in numerous reference libraries, is a very effective and flexible system of classification for engineering data. During the past ten years I have accumulated a mass of technical data, chiefly in connection with structural work, and have found the Dewey system most effective. My use of it is as follows:

A shelf of ordinary cardboard letter files is first secured, each file bearing a general subject name and its classification number. Inside of each file box, on the top index sheet, is a list of sub-titles, numbered. The manila sheets with the alphabet index tabs form some twenty pockets in each file. With a little use, the numbering scheme of the system is easily remembered and the articles can often be numbered while reading the magazine which is to be stripped and some of its contents filed. The advantages of the system are:

1. Universal use: when referring to a library index, the class number of the subject material desired is the same as that in the office file.

2. Unlimited flexibility: the use of decimals provides for any amount of detail.

3. Practically the entire elimination of cross references: the articles containing references to several sub-titles are filed as general articles in that class.

4. Possibility of numbering the entire office library in the same system. (Which I have done to my collection of books, reports, reprints, etc.)

5. Each article being numbered, it can easily be replaced in its correct position.

There is no necessity for a card index. A copy of the system of classification gives the key to the location of the desired data. Not only can an article desired be easily found, even when the author's name has been forgotten, but articles containing similar information are in the same place.

As an example of the suitability of the system to engineering data, part of it used by the writer reads:

624.	Roofs and bridges.	.6	Arches.
.0	Specifications.	.61	steel.
.1	Graphics.	.611	roof.
.2	Beams and girders.	.612	highway.
.3	Trusses, steel.	.613	railroad.
.31	roof.	.621	concrete, roof.
.32	highway.	.622	highway.
.33	railroad.	.623	railroad.
.4	Trusses, timber.	.7	Cantilever.
.45	highway.	.8	Suspension.
.5	Trusses, concrete.	.85	Movable bridges.
.55	highway.	.9	Trestles and viaducts.
		.95	Pontoon bridges.

[The foregoing article was prompted by one on the filing of engineering data which appeared in *Engineering News-Record*, May 28, 1925, p. 892.—EDITOR].

Some Notes on Aircraft Landing Field Construction

Opportunities for Specialized Field Builder Forecast—Average Costs Outlined for Making Small Layout

By Archibald Black
Consulting Air Transport Engineer, Garden City, N. Y.

THE rapidly spreading interest in air transportation in the United States deserves more than passing attention from the civil engineer and the contractor. As airline plans, which are now being financed, are carried into execution, the construction of aircraft landing fields will assume some importance. The aircraft landing field of today is usually government owned—either federal or municipal. Fields which have been provided for public use have been created with regard more to their future than to their immediate utilization. However, some very sound and substantially financed operating companies are coming into existence and it is certain that these companies will find it necessary to create a number of landing fields for their own use.

The immediate prospects, in the way of construction contracts for landing fields, will be for government projects. Practically all of these will be municipal landing fields planned for public or common use. There is also a probability of some federal contracts being available particularly through the development of Army and Navy plans. The municipal contracts will each be relatively small, but they may reach an important total as each city bids for its place on some important air route. The federal contracts will be very few in number but such as are given out are certain to reach a few million dollars each. Contracts for the construction of landing fields and equipment for privately owned corporations will loom into importance in the near future as present projects are carried into execution. The next year or so should show some start in this direction.

Substantial sums are necessary to acquire the grounds to be utilized for landing field purposes. Up to the present time this has worked against the interest of those concerned with construction contracts. So much of the available money had to be tied up in the purchase of the property that only the most meager equipment and construction could be contracted for. Fortunately this condition exists only at the start. As air transportation grows the use of the field will grow. More equipment, more loads and runways, extensions of buildings, perhaps some reconstruction, will become necessary. With growing use, the increased revenue will be taken to justify more elaborate construction even if the project does not pay its way as it stands—for most projects will be laid out with regard to their future possibilities. It will thus be clear that the initial investment in construcution, buildings and equipment, while relatively small, will be only the start and that the contractor will have a constantly growing source of additional business to look to.

By the time that these repeat orders begin to assume importance it appears certain that some constructors will have established themselves as specialists in this field of work. And it is only logical to expect that these established specialists in landing field construction will get preference in dollars and cents when reconstruction, extension or additional buildings are required. Those hoping to enter the field at a later date are bound to start under a serious handicap. Landing field design involves innumerable problems peculiar to this work and without parallel in any other line. It will be clear to those who investigate it, that the owner or the construction company, if not both, should arrange to have the selection and the design of a landing field handled under the direction of a specialist in landing field engineering. Any other course is very dangerous from the viewpoint of investment or that of safe and economical operation. A field may sometimes be worse than bad, it may be criminal

FIG. 1—CURTISS LANDING FIELD AT GARDEN CITY, N. Y.

if it causes loss of life which could have been avoided. And, from the purely business viewpoint of cost, it is amazing to note how the unintelligently planned field can cost twice as much as a cheaper one which is also better.

For some few years at least, if not indefinitely, the landing field contractor will find that he requires a national organization of representatives or branch offices if he is to negotiate construction contracts successfully throughout the country. The scattered nature of the business will make this necessary. So far, most of the municipal work has been carried out by local constructors, and political considerations naturally work in that direction. However, the established constructor of national reputation who is adequately represented locally will have advantage over the local firm if he specializes in this type of work. Experience should go far to offset local political "pull" or slight differences in the contract price. The scattered nature of the work, combined with the relatively small sums involved in the average construction contract at first, will make it necessary for the constructor to have a force available which is carried "between times" by his other work.

Federal landing field construction generally runs into substantial figures although the projects are few. It is impossible to give any intimation of what might be expected other than to say that the cost of a single project may be several million dollars. In municipal or privately owned projects, the purchase of the ground usually eats up the larger part of the available funds. While the cost of the property is dependent upon local values, field area, condition of property and number

of available sites in the locality, it might be safe to set down the general range of ground cost as being from $125,000 to $750,000. It would be difficult to set down anything closer than this range which could be safely considered as an "average" case.

The sums which are being spent for construction on landing field projects today are subject to great variation. They are affected by the possible use of the field, how far the promoters plan into the future, the condition of the ground, the funds available and many other conditions. The tendency will be for the sums set down herein to increase by leaps and bounds in the immediate future and the construction firm investigating this field should not judge its possibilities by what is being spent at this moment. At present, it is probably safe to figure that about $40,000 is the smallest sum likely to be tied up in actual construction in any project. Many will run far above this and the tendency will be for this figure to increase until field building ranks with other construction work in importance. The following table will give some indication of the class of work included in contracts, the figure after each item representing the typical modest project of today:

	Probable Minimum
Grading, filling ditches, etc.	$2,500
Drainage, of worst places only	1,000
Roadway construction within grounds	1,000
Airplane runway construction	5,000
Airplane hangars and workshops	15,000
Portable wood building for use as office	1,500
Gasoline and oil shed	250
Water line extension or well	675
Fencing, parts of field near roadways	4,000
Gasoline storage system	1,000
Incidentals	1,000
Total not less than	$32,925

Paris Plans Underground Garages

Plans for the construction of underground garages to reduce the street congestion in Paris are now being considered by the Municipal Council, according to advices to the Department of Commerce. This proposal has been handed over to a special commission for examination makes an important contribution toward the ultimate improvement of Paris street traffic.

Rail and Water Terminal and Channel Improvement Planned at Richmond

A PLAN for stimulating the commercial development of Richmond, Va., by deepening and straightening the James River below the city and by the construction of a rail and water terminal at the head of the deepened channel is now before the City Council for its approval. When this approval has been received, the plan will be submitted to the federal government for its approval and for assistance in deepening the James River.

The James River for several miles below Richmond is narrow and very tortuous and has a depth of about 18 ft. The plan for straightening the river calls for the cutting of one canal which will take out two horseshoe bends in the river and two canals which will each take out one horseshoe bend; all three canals have a total length of approximately 10,000 ft. This operation will shorten the distance from the city to the sea by 10½ miles. The deepening project calls for a depth of 25 ft. from Hampton Roads to the proposed deep water harbor site 3¾ miles below the city limits and a depth of 18 ft. from this point to the Richmond lock gate. A project already approved by the federal government calls for a deepening of 22 ft. and a channel width varying from 200 to 400 ft. The estimated cost is $7,000,000.

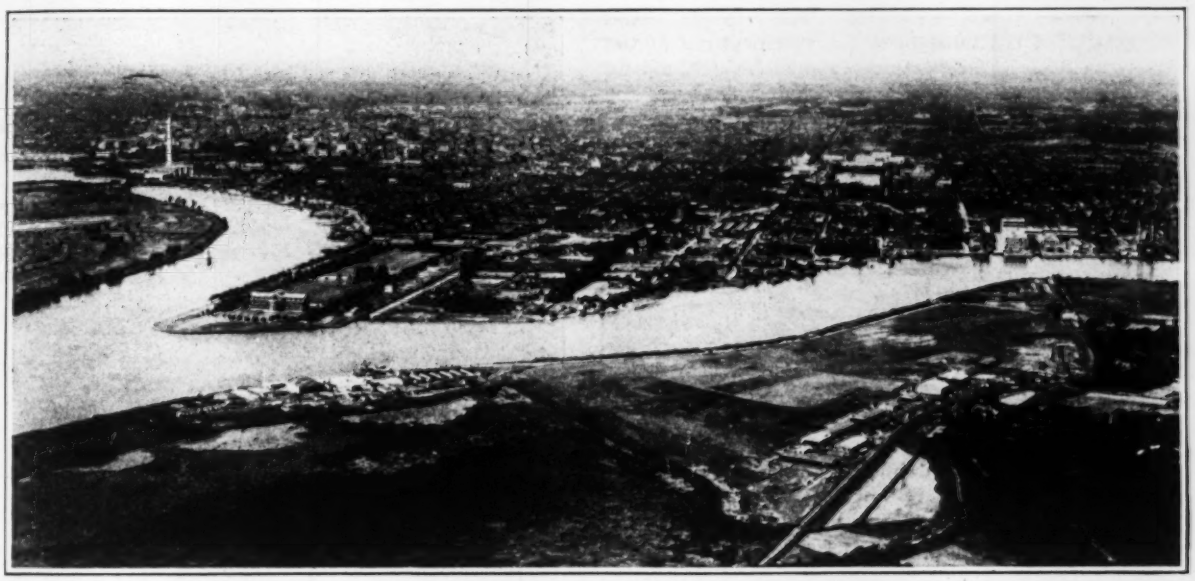


FIG. 2—BOLLING FIELD, WASHINGTON, D. C.

On account of rock in the river bed near the city, the new project locates the rail and water terminal below the city where a depth of 25 ft. can be obtained without such a large amount of rock excavation as would be necessary to extend either the 22-ft. or 25-ft. depth to the city. The terminal will be connected with the city and with the railroad, coming into the city by a belt line railroad. The cost of the belt line and the terminal is put at $3,000,000. This terminal will have 1,800 lineal feet of wharf, warehouses, open storage and cargo handling equipment. An intermediate terminal at the old city wharf will have a wharf frontage of 1,000 ft.

This study for the improvement of the James River was made by the Technical Advisory Corporation in cooperation with the Department of Public Works, Richmond, Va., R. Keith Compton, director.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Inexpensive Device for Making Crushing Tests on Sewer Pipe

By Alden Wells
Hartford, Conn.

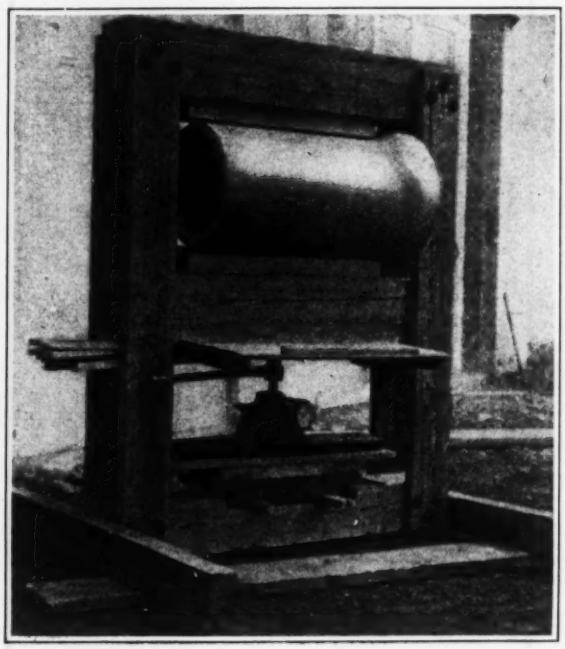
SOME time ago the contractors on a project in Hartford, Conn., desired to use unreinforced factory-made concrete pipe of 10 to 18 in. in size in place of vitrified tile pipe. The city has used considerable reinforced-concrete pipe from 24 to 66 in. in size but had not used plain concrete pipe for the smaller sizes for twenty or thirty years. It was agreed that concrete pipe could be substituted but must meet the specifications of the American Society for Testing Materials, which, among other things, specifies a table of crushing strengths for the various sizes. This seemed to be an important requirement and the engineer in charge was anxious to have crushing tests made. The test presented difficulties because of the equipment required. The contractor was ready to use the pipe, so it was essential that any apparatus needed be secured quickly.

The A. S. T. M. specifications required that the crushing load be applied evenly throughout the full length of the barrel of the pipe, 3 ft. in this case, by means of one of three types of bearings. These bearings were described in detail—either sand bearing on one-quarter the circumference of the pipe both top and bottom, or two plane surfaces, or a plane surface at the top and two round edges at the bottom. Coefficients were provided to reduce tests by the latter two methods to equivalent values of the first. The jaws of the crushing machine must open wide enough to receive the outside diameter of the pipe plus the space required for the bearing and beams used to distribute the load evenly over the length of the pipe. This total was nearly 3 ft. in the case of the pipe in question. No regular crushing machine with a large enough opening was within reach.

To overcome this difficulty the writer designed the frame shown in the accompanying illustration. The essential parts are three short 8x10-in. timbers, one above the other, the top and bottom ones being tied together by four 2x8-in. planks. The ends of the middle timber were trimmed so that it slid freely in the slots formed at each end by the planks. The pipe was crushed between the upper pair of timbers, the motive force being a loadometer jack between the lower pair.

The loadometer consisted of a screw jack mounted on a hydraulic cushion. As the jack is screwed up the pressure exerted by it is transmitted through the hydraulic cushion and measured by means of an ordinary pressure gage connected to the cushion. The gage was graduated to read directly the total pressure on the jack up to 20,000 lb. As the loadometer was only 14 in. high we could check the calibration of its gage by placing it between the jaws of an ordinary standard testing machine. When testing pipe the pressure was applied in installments of about 100 lb. at as near as possible to the specified rate, using a watch to time this operation. When in use the base of the loadometer was lightly tapped with a small hammer to guard against possible skin friction between its parts, though I never observed much indication of any friction.

The picture shows a pipe set ready for crushing with three-point bearings. The upper bearing is a block of 3x6-in. oak; the lower bearings are 1-in. quarter-round oak moldings set on a 3x6-in. oak filling piece. Some adjustments were necessary when a pipe was put into the machine to secure the best possible fit of the bearings and a proper balance over the jack so as to



HOME-MADE PIPE-TESTING MACHINE

insure an even pressure along the full length of the pipe. Tests with sand bearings were made by inserting boxes above and below the pipe. A piece of cotton cloth was used for the bottom of the upper box, being tamped to fit snugly over exactly the required part of the pipe's surface. For tests with sand we chalked on the pipe before it was put into the machine the limits of the bearings. For this I drew concentric circles on the floor slightly larger than the outside diameters of the various sizes of pipe and divided them with radial lines. Then standing the pipe on end, centered in the proper circle, it was easy to mark on it the required bearing limits. The time required to set and test a pipe varied somewhat, adjustment of bearings taking most of the time. In general, with three or four men to handle the pipe, each test required from fifteen minutes to an hour, the longer time occurring when pipes of different sizes were tested. To apply the sand test took twice as long as with three-point bearings.

The base of the frame was formed of two pieces of 4x6-in. timbers. Connections were bolted. A series of holes was bored in the vertical members at each

end through which small iron pins were pushed to hold the moving beam when the jack was not acting. Wooden shims were used on top of these pins as shown at the left. Blocking was used under the jack to compensate for the different diameters of pipe tested. The frame was originally designed for tests with three-point bearings only; later when we wanted to use sand bearings which necessitated a larger opening we cut into the bottom beam slightly to get room for the loadometer. As any deflection in this bottom beam would not affect the results this cut did no harm. A shelf was built on the bottom of the middle beam to protect the jack from damage by falling bits of broken pipe. When pressure was being applied a string was laced vertically between the upper pair of beams forming a sort of net to protect the operator from broken pieces of pipe.

Vitrified tile pipe usually broke with a sharp report and instantly collapsed. Concrete pipe often broke with a sort of tearing action, sometimes noiselessly. The failure of concrete pipe might at first be indicated only by a fall of 200 to 400 lb. on the pressure gage. The pipe would still retain its form. The jack would have to be screwed further up to distort the pipe before it fell apart.

The frame was built in the city's repair shop. I was able to borrow a loadometer from highway officials who had used it for weighing truck loads; so we thus avoided what would otherwise have been the largest item of expense. About $30 was all the cash outlay that was actually charged against making this machine.

Low-Cost Cottage for Engineer on Remote Construction Job

By George Henry Ellis
Care Kentucky Hydro-Electric Co., Burgin, Ky.

A LARGE number of engineers and skilled mechanics who follow construction work are obliged to move frequently and to live where the work is. If the job is in or near a town, the housing problem is relatively simple. It it is remotely situated, those who have families must either commute from some nearby town or build a cottage at the site of the work. Confronted with such a necessity, the writer chose to build, as herein described.

FIG. 1—HOUSE ON CONSTRUCTION JOB COST $333

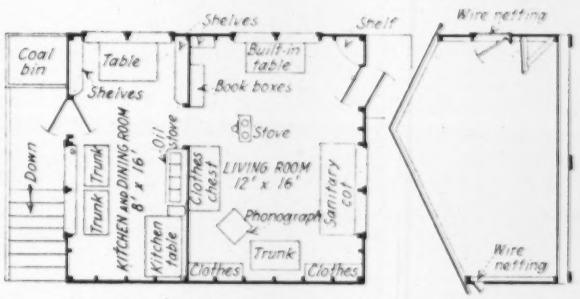


FIG. 2—FLOOR PLANS AND END ELEVATION

The Dix River Dam, Kentucky, is located five miles from Burgin, nine miles from Harrodsburg, and four miles from Shakertown, where some of the men live and commute in cars, while some walk two and one-half miles to and from Highbridge daily. Dixdam is a camp of from 700 to 1,700 men, with its own store, restaurant, moving picture theater and water supply and electric light systems. About fifty families have chosen to live at the dam, in cottages of various sorts, some of which are rented from the company, and some of which are owned by their occupants with the understanding that they shall be removed or otherwise disposed of when the job is completed and the camp abandoned.

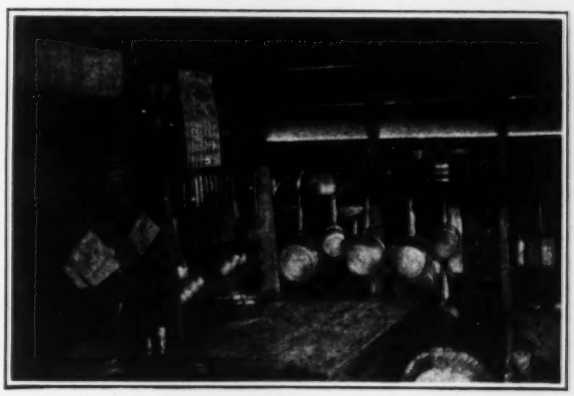


FIG. 3—THE BUSINESS CORNER OF THE KITCHEN

Design of a cottage under these conditions is quite a problem. The house must, of course, afford protection from the weather and be nice enough for one's family to live in; but it must also be cheap enough so that the total cost, when divided by the probable period of occupancy, will not be excessive. The cottage described here is not submitted as a good design in architecture, but to show how cosily such a place can be fitted up when proper attention is paid to it by the "house engineer," whose praises "Elldee" sank none too highly in his poem, *Engineering News-Record*, Nov. 20, 1924, p. 848.

The house has double windows to the north, east, and south, doors to the north and south, and a screened ventilator to the west. The windows are arranged to hinge in so that any incoming air is deflected upward. This provides ventilation without the unhealthy results due to a direct draft. The ventilator was arranged with a string and pulley to be opened or closed from the inside. When cold weather set in last fall, this was nailed shut and covered with tar paper battened down. This house was easily

warmed in winter, and was comfortably cool during the hottest days last summer. Most of the furniture is home-made. The kitchen table in the view herewith was designed by the "household engineer." The tops of all tables are built of No. 2 flooring, which was obtained at the same price as the shiplap of which the

FIG. 4—LIBRARY END OF THE LIVING ROOM

house is constructed. It does not shrink, leaving cracks, as does the shiplap.

Costs were as follows:

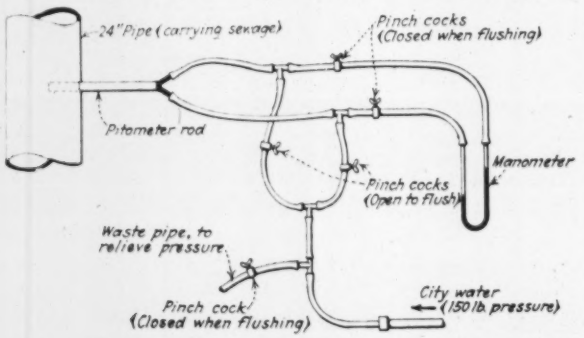
Lumber	$147.25
Windows and doors	18.00
Paper and roofing	25.85
Nails and hardware	19.40
Electrical equipment	8.09
2 oilcloth rugs	22.00
Labor	92.50
Total	$333.09

This cottage has been occupied about fourteen months at this writing. Cost per month has been about $23.50. Each additional month that the job lasts reduces this monthly cost.

Measuring Sewage Flow by Pitometer

BY ARTHUR L. SHAW
Designing Engineer, Metcalf & Eddy, Boston, Mass.

DURING recent tests of the 24-in. centrifugal pumps in the new Washburn St. sewage pumping station in Springfield, Mass., the most convenient and practical method of determining the rate of discharge was by means of a pitometer inserted through corporation cocks tapped into 24-in. vertical cast-iron discharge pipes. It was found, however, that when the usual apparatus was used, the small orifices of the pitometer quickly became clogged by solid particles in the sewage, causing


24" Pipe (carrying sewage)
Pinch cocks (Closed when flushing)
Pitometer rod
Manometer
Pinch cocks (Open to flush)
Waste pipe, to relieve pressure
Pinch cock (Closed when flushing)
City water (150 lb pressure)

ARRANGEMENT FOR FLUSHING PITOMETER ORIFICES

From Job and Office

Hints that Cut Cost and Time

fluctuations in manometer readings which made the results unsatisfactory and unreliable. It was soon apparent that some means of clearing the orifices must be devised which could be followed quickly by manometer readings before stoppage again took place.

Several expedients were tried and finally the arrangement of rubber tubing and pinch cocks as illustrated in the accompanying diagram was improvised, whereby city water could be admitted to flush the pitometer orifices. When abnormal manometer readings indicated that clogging had taken place, the pinch cocks were manipulated to admit clean water under pressure to first one and then the other of the pitometer tubes, first taking care to close the cocks on the manometer tubing to avoid blowing out the liquid in the U-tube. The city pressure was nearly 150 lb. and the tubing used was of a light weight, so that it was necessary to open the waste cock between flushings to prevent the rupture of the tubing. This apparatus permitted resumption of manometer readings promptly after the obstructions were flushed out and made it possible to obtain reliable observations before the behavior of the manometer columns indicated the necessity for further flushing.

Place Slag in Sewage Beds by Belt Conveyors

RECONSTRUCTION of sewage disposal plant at East Sparta, Ohio, for the city of Canton requires the moving of more than 130,000 cu.yd. of slag. About 50,000 yd. were removed from the filter beds, the beds were then rebuilt and now are being refilled with 80,000 yd. of fresh slag.

The old slag was loaded into Ford trucks by two clamshells and one self-feeding bucket loader. It was found that the daily output was about 1,000 yd. of slag, of which amount 600 yd. were handled by two cranes and 400 yd. by the loader.

For handling the new material, a unique system of portable belt conveyors has been provided by the Barber-Greene Co., from whom this information was received. Slag, furnished by the Standard Slag Co., Youngstown, Ohio, is dumped from the cars into a small steel track hopper which feeds onto a short portable belt conveyor. The belt is 18 in. wide by 30 ft. long and is provided with steel cross cleats which enable the machine to carry the slag easily up from the pit to discharge onto the next conveyor. This 30-ft. conveyor in the pit is mounted on swivel wheels, so that it can be moved from one track pit to another as the filter beds are filled with slag.

The second conveyor is an 18-in. x 60-ft. shuttle. It is mounted high enough to discharge directly over the wall. Four extended legs carry axles and single flanged wheels which run on a standard 30-in. gage industrial track. With this shuttle mounting it is possible to deliver the slag 60 ft. or more in either direction from a track pit. This obviates the necessity for many track pits, which is quite a consideration since the filter beds

From Job and Office

For Contractor and Engineer

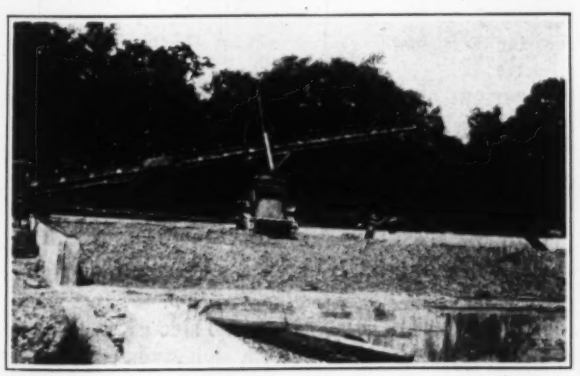
SLAG HANDLING BY PORTABLE BELT CONVEYORS
From track hoppers slag elevated by 30 ft. conveyor to 60 ft. shuttle over wall or as in picture to 111 ft. conveyor and finally placed by flexible chute.

are 880 ft. long. With the use of the shuttle the six track pits are placed 150 ft. apart.

From the shuttle the slag is delivered directly over the wall or to an 18-in. x 111-ft. belt mounted on special trucks so that it can be moved at right angles to its length. The trucks are made with four wheels to run on 30-in. gage track. Since this conveyor at all times is being supported on the newly laid slag, the trucks are flexibly attached to the conveyor support, thus allowing considerable variation for irregularities in the track. In order to reach the filter beds farthest from the railroad track—the whole basin being 440 ft. wide—it will be necessary to extend the reach of the conveyor system by means of another belt similar to this 111-ft. machine. This machine will be 220 ft. long.

A tractor crawler chassis taken from a bucket loader carries the last conveyor, an 18-in. x 81-ft. machine. The connection between the chassis and the conveyor is such that the crawler unit can turn about freely under the conveyor. While the stone is being discharged into the filter bed from the belt of this machine, the chassis is moved to "fan" the conveyor about its hopper as a pivot. Further flexibility is obtained in this machine by the use of a swivel discharge chute 15 ft. long.

When moving from one setup to another, the crawler chassis is turned at right angles to its "fanning" position and either pushes or pulls the hopper end along the slag fill to the new position.



CHASSIS OF CRAWLER "FANS" BELT CONVEYOR ABOUT ITS HOPPER AS A PIVOT

All of the conveyors are driven with electric motors but the crawler chassis is driven by a gasoline engine. When this job is completed, the contractor, the Holmes Construction Co., plans to take the chassis, add the necessary boom and feeder and have a standard self-feeding bucket loader which can be used on road work. The same applies in large part to the conveyors, which will be changed to meet conditions on the next job. The intermediate sections are standard lengths and can be taken out or added in the field.

A car of slag is easily unloaded and deposited in the filter beds over the conveyors with only three to five men in 40 minutes. Ten to twelve cars a day are handled.

Seven Pile Dikes Protect Missouri River Bank Against Erosion

By F. Y. Parker
Assistant Engineer, War Department, Kansas City, Mo.

DUE to a sharp curve in the river above Sissons Bend, 12 miles below Kansas City, Mo., on the Missouri River, the current has been thrown against the left bank over a distance of about 3 miles with the result that the bank has caved and the river widened

PILE DIKE AND MATTRESS FOR BANK PROTECTION

to over 3,000 ft. in this section. During 1913, 1918 and 1920 pile dikes were put in to contract the river. They were effective for a few years but ultimately they weakened with age and were destroyed by ice and drifts. Rapid bank erosion followed and in the winter of 1922-23 an average recession of 400 lin.ft. was noted.

A system of six pile dikes was completed during 1924, but it was found that one more downstream dike would be needed to insure the retention of deposits and force the channel definitely to the right bank. During the summer of 1925 this seventh dike, 1,800 ft. long, was built of peeled cottonwood piles. Because this downstream dike does not need great strength except at the river end, where ice and drift are greatest, cottonwood could be used instead of the usual hardwood

piling. Thus, approximately $5,000 were saved in the construction of this seventh dike.

In putting in this dike a foot mattress was constructed and ballasted along 200 ft. of predriven unprotected dike. A pocket deep enough to float a piledriver was washed in a previously formed bar on the dike alignment and a driver with the leads facing the dike was put in this pocket. From the top of the leads a steel cable, leading from the drum over the sheave, was attached to the end pile of the dike and a block with a hook was placed thereon. Staggered holes 10 ft. apart and 4 to 5 ft. deep were dug on alignment in the bar, the piles were cut to required length and attached by chain to the block on the cable and dragged to position by raising or lowering the cable. A jet pipe 15 ft. long was placed against the upended pile and the pile oscillated until a penetration of 15 ft. was obtained. As the jetting went forward mattress construction and ballasting followed. To prevent uplift after penetration, a pile was lowered by the cable on the top until a fill was made.

Sections of steam pipe were coupled and laid from the driver pump across the bar to the work so that only a short length of hose was necessary. With this apparatus and method 16 piles with 15-ft. penetration were easily jetted during an 8-hr. day.

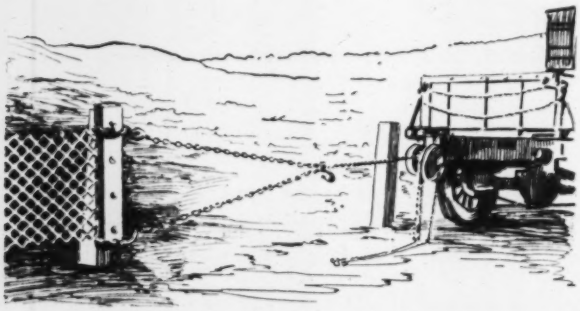
Erecting Wire-Link Highway Guard

METHODS tried out by the Nevada Department of Highways in the erection of 200 ft. of elastic wire-link highway guard on the Lassen volcanic highway near Reno in the district of E. T. Hinshaw, division engineer, have shown that a chain block and maintenance truck may be used in stretching the wire fabric with least time and effort.

Cedar posts, 6x6 in., 6½ ft. long and painted white, were first set on 10-ft. centers, 3½ ft. below grade around the curve of the road. End posts were supported in the ordinary manner by 4x6 braces. The guard was delivered on the job in 100-ft. rolls. The first operation was that of unrolling the fabric along the right of way on the road side of the line of posts, one roll being stretched and attached before the other was unrolled. Next, the fabric was attached around an end post by means of ordinary staples, neither notching nor drilling of holes being necessary. A special clamp was bolted to the far end of the 100-ft. section of wire and attached by a chain sling to a chain block fastened to the corner of the frame of the maintenance truck. The truck was driven ahead until the chains went taut. The wheels were then blocked. The fabric was stretched by running up the chain block until the guard was sufficiently tight to be fastened to the posts. Staples were used on each post to hold the fabric in place.

When the first 100-ft. length was secured to the posts, the second section was spliced on with a loose picket twisted through the two ends to form a continuous guard and the stretching operations repeated. A temporary brace was placed in front of the last post to which the first section was fastened to lessen the strain while the next section was being stretched and stapled. At the curve the truck was placed on the outside of the posts to assure proper stretching and aligning of the fabric.

The entire job including the setting of posts was done by two men, according to Thomas A. Bither, of the California Corrugated Culvert Co., who supervised the installation. The wire-link guard installed was the Hi-Way Guard, manufactured by the Page Steel & Wire Co., who furnished the information upon which this article is based.

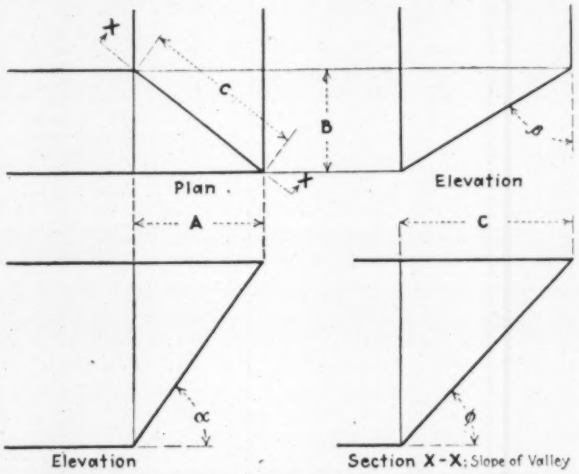


TRUCK USED TO STRETCH HIGHWAY GUARD
Wheels of truck blocked and chain block run up to stretch fabric tight enough to fasten to posts.

Determining Hopper Valley Angles

BY GEORGE N. SMITH
Cleveland, Ohio

I HAVE often found it necessary to know the angle of a hopper without making a number of lengthy calculations. This can easily be done if only the angles of the sides with the horizontal are known. The following



DETAILS FOR DETERMINING VALLEY ANGLE SLOPES

solution will enable one to obtain the angle in a few minutes:

Figuring by squares, the hypothenuse C equals $\sqrt{A^2 + B^2}$.

The sides A, B and C are the cotangents of their respective angles α, β and ϕ.

Therefore, $\cot \phi = \sqrt{\cot^2 \alpha + \cot^2 \beta}$.

With the sides C and B given with their respective angles ϕ and β, the side A equals $\sqrt{C^2 - B^2}$.

Therefore, $\cot \alpha = \sqrt{\cot^2 \phi - \cot^2 \beta}$.

If, when having the angle of one side given and it is necessary to maintain a certain valley angle, the angle of the other side may be found by using the formula $\text{Cot } \alpha = \sqrt{\cot^2 \phi - \cot^2 \beta}$.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Telescoping Gas Pipe

Sir—I have read with interest the description in *Engineering News-Record*, Sept. 3, p. 392, of the telescoping gas pipe on the Union Pacific-Southern Pacific bridge over the Willamette River at Portland, Oregon. The following facts may not have been brought to your attention.

This telescoping gas pipe arrangement was devised by John Lyle Harrington and is covered by patent. It was installed when the bridge was built in 1912 and has been in use ever since. Evidently certain of the stuffing box and similar details have been revised, probably based upon the maintenance experiences of the twelve or thirteen years' service of the original details. The double ball joint with steel elbow was provided in the original installation and shows on the patent drawings. The oil seal around the gland packing was not used originally.

There is a brief description of this installation in *Transactions*, Am.Soc.C.E., Vol. LXXXIV, p. 619.

New York, Sept. 4, 1925.

J. E. HOWARD,
Harrington, Howard & Ash,
Consulting Engineers.

The Kansas City Garbage Disposal Contract

Sir—My attention has been called to the editorial note relative to the Kansas City garbage disposal contract which appeared on p. 918 of your issue of June 4. The matter of proper garbage collection and disposal for Kansas City is one concerning which the Chamber of Commerce has given a great deal of careful study and thought for several years. It seems to me that perhaps your editorial comment was based on a misapprehension of some of the facts bearing on this problem which has confronted the city.

On Jan. 2, 1923, a former city administration entered into a contract for the collection and disposal of garbage for a period of ten years, which contract was subsequently approved by the City Council. This contract was opposed by the Chamber of Commerce because it was let without competitive bidding, because the contract price appeared to be excessive in amount and because the contract was, in the opinion of our committee, so loosely drawn that it did not properly protect the interests of the city. Fundamentally the Chamber of Commerce opposed the letting of that contract or any contract for garbage collection and disposal until a scientific survey had been made as a basis for entering into a contract. There were other objectionable features in the proposed contract. The city proposed to build a plant at its own expense and lease it for treating the garbage under a patented process, although the city was given no right to make use of the patented process if it took over the plant at the end of the contract period. Although these objections were presented to the mayor and to the council, the contract was finally approved. Thereupon the Chamber of Commerce and other taxpayers brought injunction proceedings which resulted in a decree by the Circuit Court permanently enjoining the carrying out of the contract. That case is now pending in the State Supreme Court on appeal.

In February, 1924, the same administration made a so-called emergency contract for the collection and disposal of garbage, which was in fact a ten-year contract to take effect until and unless the contract previously enjoined should become effective. This so-called emergency contract was also let without competitive bidding and was subject to some of the other objectionable features of the prior contract.

When the present city administration took office in April, 1924, the so-called emergency contract had not yet become effective, and garbage was still being collected under a prior contract which expired in June, 1924. Upon being confronted with the necessity of providing for garbage collection and disposal and being advised that the ten-year contract of January, 1923, and the emergency contract of February, 1924, were invalid, the present administration undertook to bring about a permanent solution of the problem. Arrangements were made for temporary collection. Early in the summer of 1924 the administration undertook to provide for a complete engineering survey for use in preparing detailed plans and specifications for the letting of a ten-year contract for garbage collection and disposal. At the instance of the mayor and Hospital and Health Board, an ordinance was introduced in the Common Council providing for the employment of Samuel A. Greeley of Chicago and Black & Veatch of Kansas City, to make the survey. Every effort was made to have this ordinance passed by the council but after pending for several months it finally failed of passage. This disappointed our committee because it had taken the position from the outset that such a survey should be had in connection with the making of a long-time contract.

The mayor and Hospital and Health Board, being confronted with the necessity of making some proper provision for garbage collection, employed Mr. Greeley to prepare specifications based upon all available data, for the purpose of letting a contract by competitive bidding. These specifications were drawn in great detail and provided, among other things, for a survey which was to be made by engineers employed by the city at the joint expense of the city and the contractor, which survey would be used as a basis for working out the contract, for determining the character of service and to provide a basis for the city to determine the advisability of later taking over the work of collection and disposal. This, in my opinion, comes as near to carrying out the principles which you announce in your editorial, and for which the Chamber of Commerce has been contending, as it was possible under the circumstances.

After bids had been received and tabulated the contract was awarded to Paul Patton as the lowest and best bidder. Shortly after the awarding of the contract by the Hospital and Health Board, a suit was brought to enjoin the city from entering into the contract, on the ground that the former contracts outstanding were still valid contracts, and that entering into a new contract might impose liability upon the city for damages. This injunction suit was heard in the Circuit Court upon an application for a temporary injunction, and the temporary injunction was denied.

Later the suit to which you refer was filed in the name of one of the unsuccessful bidders, but as a taxpayer's suit. The decision of the court you mention was made upon the application for a temporary injunction, and was not a final decision on the merits of the case. Subsequent to this decision and subsequent to the time of your editorial, an adjustment of the contending interests was effected and this suit was dismissed. The contract with Paul Patton has now been approved by the Common Council and has become effective. Under this adjustment, as we understand it, Patton is to collect all garbage in accordance with the specifications, and the disposal of the garbage has been sublet under the terms of the specifications to another company and is to be carried out in accordance with the specifications. The engineering survey provided for in the contract will now be made and the results thereof will be available for the purposes already indicated.

It is my understanding that under the specifications as drawn, there was in fact real competitive bidding, and while it no doubt was desirable that an engineering survey should have been made in advance of preparing the specifications, under the circumstances stated this was impossible and it seems to me that the best interests of the city were served by the procedure that was adopted.

I believe that the citizens generally are well satisfied with the solution of this problem, and that under the contract, if strictly enforced, the city is likely to have as satisfactory garbage collection and disposal service as has any city which operates under the contract system.

Kansas City, Mo., July 28, 1925.

RAY W. WILSON,
Secretary Civil Department,
Chamber of Commerce.

[The following paragraphs relating to the specifications on which bids were received on March 10, 1925 are from a letter to the editor by Mr. Greeley, published with the permission of the latter.—EDITOR.]

These specifications were prepared to cover the service to be performed. The details of methods were deliberately left out of the specifications so as to relieve the city of any responsibility other than an actual securing of satisfactory service. Bids were, therefore, asked for a service rather than a construction project. This was not an unreasonable decision because, as a matter of fact, in garbage disposal the cost of collection involves little by way of construction and includes over 80 per cent of the cost as indicated by the Kansas City bids.

In recognition of the point emphasized by the editorial note that the specifications were indefinite as to type of disposal plant and the like, the following points among others are pertinent:

(a) Bids were asked on a unit price per ton, so that the actual compensation to the contractor was definitely related to the service rendered. This service was completely covered in the specifications.

(b) The contract was to run for ten years, but the city was given the option of taking over the work at any time after the first five years. This was done so as to permit the city to develop its own plans later, should they find that desirable and still give the contractor a sufficient time to develop his work.

(c) To keep the city fully informed on the character of service being rendered and the desirability of taking over the work at any time, provision was made in the specifications for a technical survey during the first year of the contract, to be made jointly by the city and contractor. It was expected that the results of this investigation would be kept up to date by further study from time to time.

(d) To assist contractors further in bidding and yet not to involve the city in responsibility as to the method of giving the specified service, the engineers submitted a report which accompanied the specifications and which outlined in considerable detail to bidders the views of the city on the various aspects of the work.

(Signed S. W. GREELEY.)

[We regret that the brevity of the editorial note in question made it impossible to reflect the difficult political and administrative conditions at Kansas City, and the great improvement in the 1925 contract over 1923. We also regret that we did not make it more clear that we had in mind the part of the contract dealing with disposal methods and plant, rather than the combined service of collection and disposal.

Since the foregoing paragraph was put into type we have been informed that on Aug. 27 it was decided that the sub-contractor for disposal, mentioned near the end of Mr. Wilson's letter, will put in a plant making use of a process for producing hog and chicken feed, said to be controlled by the Pan-American Feed Milling Co., which is the concern that was to have built a disposal plant under the contract of 1923 with money which was to have been provided by the city.—EDITOR.]

A Point in Rectangular Slab Design

Sir—When a square or oblong reinforced-concrete slab is supported on all sides it is customary to design the steel for the two spans in accordance with the ratios of the load carried to them. These ratios are given in various textbooks on design.

When the ratio of length to breadth of slab is 1.4 one textbook gives the ratio of load carried by the shorter span as 0.80 and another gives 0.90. In a square slab they both give the ratio as 0.50.

Turneaure and Maurer's "Reinforced-Concrete Construction" gives a formula for maximum deflection of rectangular reinforced-concrete beams as follows: $D = \frac{c_1 W l^3 n}{E_s b d^3 a}$.

The fact that one layer of steel rods is above the other results in a different value of d for rods in the two spans and this in turn results in a different moment of inertia and a different value of ratio of steel to concrete, both of which affect the factor a in the above deflection formula.

By changing W in the formula to $w \times$ span in feet, and taking a strip one foot wide through the center of the slab in each direction, and knowing that D must have the same value for each span, D can be found in terms of w, the load per square foot, for each span.

Assuming a slab 10 ft. square and 4½ in. thick with the lower layer of ½-in. round rods having a depth to center of steel of 3½ in. and the other layer having a depth of 3 in. and assuming a total load of 200 lb. per sq. ft., with 100 lb. going to each span, I computed the spacing of the rods, with $M = \frac{wl}{10}$, and f_s not to exceed 16,000 lb. per sq. in. and f_c not to exceed 650 lb. per sq. in., as 9½ in. c. to c. for the lower rods and 7½ in. for the others.

I computed the deflection at the center of the span which ran parallel with the lower rods as $0.0009\ w_1$, and the corresponding deflection for the other span as $0.00133 w_2$.

Therefore $w_1 = 1.48\ w_2$, and w_2 plus $1.48\ w_2 = 200$, so $w_2 = \frac{200}{2.48}$ or 80.6 lb. per sq. ft. and $w_1 = 119.4$ lb. per sq. ft.

If there is no mistake in the figures the stresses in the steel or concrete would be about 20 per cent more in the span parallel to the lower layer and 20 per cent less in the other span than provided for on the basis described.

I think that some cases might be found with slabs having different dimensions and arrangements of steel where the stress variation would be considerably more or less than shown in this case, and would offer the suggestion that it is desirable to use the deflection formula occasionally as a check.

FRANK S. BAILEY,
With Metcalf & Eddy.

Boston, Mass.,
Aug. 24, 1925.

Two Water Mains in Wide Streets

[*Additional comments on the plan advocated by Thomas F. Wolfe and discussed by 26 water-works engineers and superintendents in our issue of Aug. 27, p. 332.*—EDITOR.]

Sir—I agree with Mr. Wolfe in his opinions that two mains with suitable cross-connections are desirable in a wide street, rather than a single main in the center of the street. The outstanding advantage of this method is that the street pavement is interfered with only at cross-connections; the significance of this fact can hardly be overemphasized in view of the increasing congestion of traffic. The gain from shorter and therefore in many cases smaller services is obvious.

I take issue with Mr. Wolfe in his statement that hydrants should be placed on one side of the street only. A better design in my opinion would be to make the smaller main at least 6 in. in diameter with as many hydrants upon it as the hydraulic conditions warrant; this arrangement would permit the use of short lines of hose and would under ordinary conditions prevent the necessity of carrying lines across the street.

In my opinion the ultimate advantage to be gained by the two mains outside of the street pavement warrants an increased cost if such is necessary.

F. A. MCINNES,
Consulting Engineer.

Boston, Mass., Aug. 21, 1925.

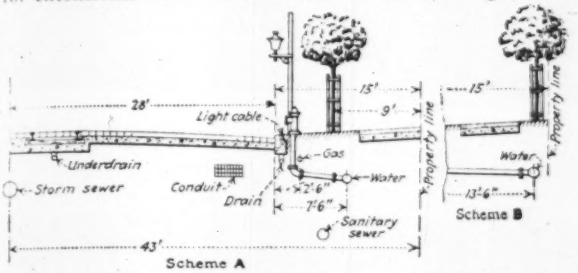
Sir—I am very much in favor of two water mains in wide streets in municipal territories where streets are being paved and improvements installed as the property is developed. I think it is desirable to locate the mains about 5 ft. from the curb. This allows for installation of fire hydrants close to the curb and the water main does not interfere with any foundations for cellar areas extending beyond the buildings nor are pipe lines endangered when building operations are carried on close to the buildings. In suburban and rural districts it would be rather expensive to lay a line on either side of the street, as it is only in territories fully developed that such an arrangement is desired. To lay services to each individual lot, services which, as a rule, are not located just where desired when used and very often are of inadequate size, is not a good plan.

It is the practice in the companies under my supervision to lay the water main, even when only one main is laid, about 5 ft. from the curb line in the street. Service connections can either be drilled across the street with an auger or jacked with hydraulic jet, depending on soil conditions, so as to interfere with the surface of the pavement as little as possible.

H. F. HUY,
President, A.W.W.A., Mgr., Western New York Water Co.

Buffalo, N. Y.

Sir—It is impracticable to consider the proper location of only one utility line in a street. A proposed scheme for Akron, Ohio, providing for all the utility lines, is shown by the accompanying sketch. I used this plan in the Firestone Park development eight years ago on streets 80 ft. or more in width, regardless of the presence of street-car tracks. The results have been very satisfactory. The pavements have never been torn up for repair or leaks or for extensions. The cost was no more than for single lines.



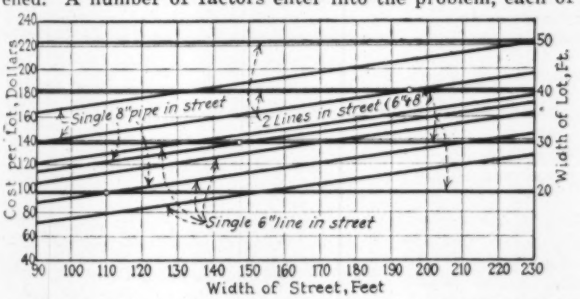
TWO PROPOSED PLANS FOR LOCATING DUPLICATE STREET SERVICE LINES AT AKRON, OHIO

Half cross-section of 86-ft. street with double car tracks and storm sewer in center. B is identical with A except for relative positions of sidewalk, trees and water mains and shortening of water service connections.

As the sketch shows, the storm sewer is in the center of the street. There are no laterals except to street inlets, and the possibility of digging up the street, for repairs or additional connections, is remote. Therefore, the pavement, especially between the rails, remains undisturbed. The location of the trees and boulevard lights appears to be the most difficult problem. If it were possible to secure the strip of ground, just inside the property lines, for street trees, the solution would be simple. The boulevard light standards ought to be located between the sidewalk and curb, but if the trees are also located here the light rays are absorbed by the trees instead of illuminating the street.

Akron, Ohio, Aug. 29. E. A. KEMMLER,
Engineer of Bureau of Highways.

Sir—The Detroit Department of Water Supply has on many occasions given careful consideration to the proposal that more than one water pipe be laid in the street in order that the length of service connections may be shortened. A number of factors enter into the problem, each of



COMPARATIVE COSTS OF ONE AND TWO WATER MAINS FOR DIFFERENT STREET AND LOT WIDTHS

Assuming one 8-in. main in center with long service connections against a 6- and an 8-in. main 15 ft. from property line, with short service connections. All service pipe ¾-in. No allowances for cross-connections between mains at street intersections.

which is partly or wholly an unknown quantity. These include width of lots, character of soil, the presence or absence of street-car tracks, distance from property line to each pipe when two are laid, and length of blocks. It is seldom found possible in Detroit to lay a street main within 3 ft. of the property line. As far as possible this work is done with the aid of machinery and usually a pipe line is laid about 15 ft. from the property line or between the sidewalk and the location of the curb when the street is paved.

Using present data costs, with Detroit conditions, and assuming that the pipes are laid 15 ft. from the property line, and that the soil will allow borings to be made under the pavement through which service pipes can be extended without necessity of disturbing the pavement, omitting the item of cross-connections which may or may not be of importance in this comparison, and assuming ¾-in. service connections, it appears (see sketch) that the cost of one 8-in. pipe with the corresponding long connections, and two pipes, 8- and 6-in. with the shorter connections, will for 20-ft. lots be equal for streets 110 ft. wide; for 30-ft. lots, 150 ft. wide; 40-ft. lots, 190 ft. wide; and 50-ft. lots, 230 ft. wide. Figures show that it may or may not be desirable to use two pipes and that each town should work out its own problem.

On account of the very wide pavements that are found on many of Detroit's main thoroughfares and the difficulty that is encountered in boring the entire width, this department generally lays two pipes in streets whose width exceeds 86 ft. The lots abutting such streets generally have a width of 20 feet. G. H. FENKELL,
General Manager of Water-Works.

Detroit, Mich., Sept. 1.

Sir—The following information as to the practice of our company in laying two water mains on wide streets is supplementary to my letter upon the subject published in your issue of Aug. 27, p. 333. The streets or avenues in which we have laid two mains are 75 to 80 ft. wide between curbs and in some cases have "islands" in each block. All the lots on these streets have 25-ft. frontages.

In wide streets where only one main has been laid the municipal officials generally ask us to tap our water main and run services to the curb before the paving work is done. Where we do this we charge to the municipality the cost of the work done for inactive service connections and when the services are connected we refund the money to the municipality. Under the ruling of the New Jersey Public Utility Commission water companies are required to stand the cost of services from the main to the curb and also the cost of maintenance, but the companies are not compelled to go to this expense except for the actual supply of water to consumers. Brass pipe has been used by this company for all services between the street main and the curb for the past three years. D. W. FRENCH,
Superintendent, Hackensack Water Co.

Weehawken, N. J.,
Sept. 14, 1925.

County Government and Engineers in Missouri

Sir—Your comments on the administration of county affairs in an editorial in your issue of Aug. 13, 1925, p. 249, does a rank injustice to the officers in charge of the county business.

In Missouri the affairs of a county are administered by a county court, composed of three members. One member, the presiding judge, is elected by the county at large, and the other two, associate judges, are elected by two districts of the county, into which the county is divided for that purpose. In some other states the corresponding body is called a board of county commissioners.

The members of the court are almost uniformly good representative men of the county. They are close to the voters and we would naturally expect them to be of good moral fiber like the sturdy yeomanry back of them; and in the great majority of cases this is true of them. For the most part they are men who by force of character have become leaders of their respective communities.

As to persons appointed by the county courts to the office of county highway engineer, it is doubtless the aim of the courts to appoint persons having the technical qualifications required by law and having the moral qualifications required for any public office. The statutes provide that the person appointed to that office shall have a practical knowledge of civil engineering, shall be skilled in road, bridge and culvert building and in general road work.

I write this that you may be set right on the question of the merits of our county courts and boards of county commissioners, and their administration of the affairs of their counties. JOSEPH B. MARCH,
County Highway Engineer,
Bates County.

Butler, Mo.,
Aug. 29, 1925.

[It is always heartening to have a man stand up for his own. We should be glad to hear from some at least of the other 47 states and 3,064 counties in the Union.—EDITOR.]

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Water Diversion at Niagara Within the Law

International Board Reports That the Present Diversion Is Within the Treaty Provisions

The Niagara Control Board, formed by joint action of the United States and Canada, in a report dated June 15, 1925, but just released by the United States Department of State, certifies that the amount of water being diverted from the Niagara River for power purposes is within the treaty obligations of each country.

This board, composed of Major P. S. Reinecke, United States Corps of Engineers, and J. T. Johnston, as Canadian member (W. J. Stewart, recently deceased, was Mr. Johnston's predecessor), has been examining closely the use of water on the Niagara River since the middle of 1923 when the government decided that such a study should be made. Under treaty, the power plants on the United States side are limited to an amount not exceeding in the aggregate a daily diversion at the rate of 20,000 cu.ft. per second and those within the Province of Ontario, 36,000 cu.ft. per second. The board reports that it adopted a method of determining the amount of water diverted by the several power companies and directed that hourly records be kept of the diversion by these companies. The method of measurement adopted determined, at hourly intervals, the power output of the various plants by watt-meter readings, and by computation therefrom the amount of water used by the various hydro-electric units is obtained by means of curves showing the relation between water consumption and power output for the different units as determined by efficiency tests. In addition to that, the board inspected the records of the power companies which have been made for years indicating the amount of water diverted from the river.

No Excess Diversion

Both tests and inspection of the records from the time it was physically possible from the status of installation of machinery to have exceeded the treaty limitations all show that the diversion of water by the companies on the American side has at no time exceeded in the aggregate a daily diversion at the rate of 19,500 cu.ft. of water per second. The remaining 500 cu.ft. per second is reserved by the United States for diversion for power purposes through the New York State Barge Canal. While no accurate measurement has been made, the board believes that it has not been exceeded. A careful inspection and investigation by the board of records of the several power companies on the Canadian side from the time it was physically possible from the status of installation of machinery to have exceeded the treaty limitations, definitely shows that the diversion of water has at no time exceeded in the aggregate a daily diversion at the rate of 36,000 cu.ft. of water per second. Since Jan. 1, 1925, hourly measurements have been made at the power plants on both sides of the river at Niagara Falls, and these show that all the power plants have been and are being operated in entire compliance with the provisions of the treaty.

Engineering Fifty Years Ago

From *Engineering News*, September, 1875

How Inventions Are Made

THE life of George Stephenson proves that notwithstanding the novelty and great importance of his improvements in steam transit, he did not discover these improvements. He did not discover that a floating embankment would carry a railway across Chat Moss, neither did he discover that the friction between the wheels of a locomotive and the rails would enable a train to be drawn by tractive power alone. Everything connected with his history shows that all his improvements were founded on a method of reasoning from principle, and generally inductively; to say that he "discovered" our railway system, according to the ordinary construction of the term, would be to detract from his hard and well-earned reputation, and place him among a class of fortunate schemers who can claim no place in the history of legitimate engineering.

Count Rumford did not by chance develop the philosophy of forces upon which we may say the whole science of dynamics rests; he set out upon a methodical plan, to demonstrate conceptions that were ready matured in his mind, and to verify principles which he had assumed by inductive reasoning.

N. Y. Port Authority Asks Bids on Hudson River Bridge Borings

The Port of New York Authority is receiving bids to be opened Sept. 29 for making water borings at the site of the proposed bridge across the Hudson in Upper Manhattan. The work consists in making borings in the bed of the river within a locality bounded approximately by the lines from 170th to 185th Sts., Manhattan, to points approximately opposite in the Borough of Fort Lee, N. J. Invitation to bidders stipulates that the work of making the borings will start within ten days after the contract has been awarded. More detailed information on the proposed work can be found in the Searchlight Section in this issue.

Delaware River Bridge Toll Dispute Not Settled

Commissions Adjourn Joint Meeting To Avoid Open Deadlock—Vital Contracts Pending

No progress was made in clearing up the Delaware River bridge toll situation at the joint meeting of the commissions of the two states on Sept. 18. Specifications for three additional contracts for work required to complete the bridge had been prepared by the engineers and submitted to the commission for approval and advertising. Consideration of these contracts was expected to bring about an open deadlock between the commissions because of the decision of the New Jersey commission (reported Sept. 3, p. 399) to vote against further contracts or the expenditure of money for work not already under contract until the right of their state to collect tolls is fully recognized. However, the commissions joined issue on a recommendation of the chief engineer for the temporary appointment of a draftsman for the design of electrical equipment, which is part of the work not yet under contract. The Pennsylvania commission voted for and the New Jersey commission voted against the recommendation, thereby preventing the appointment. Adjournment followed soon after this vote, before the new contracts were taken up.

Further action is thereby deferred until the next meeting, Oct. 2. In the meantime the issue has been referred to legal departments of the two states, who may find a way of reconciling the Pennsylvania demand for a toll-free bridge with the New Jersey bond-issue obligation for tolls. One of the contracts to come up provides for wrapping the cables, and it is claimed that this contract is urgent because continued exposure of the cable wire to the weather may allow rusting to begin.

Latin-America to Be Represented on Highway Research Board

In view of the constantly enlarging program of highway development in Latin-America the Highway Research Board of the National Research Council at Washington, D. C., has asked Latin-American universities to designate honorary members who shall serve as liaison officers between the board and the universities. Similar contracts now exist with universities in the United States.

As a result of these contracts, the Highway Research Board expects to secure a wider field for getting information and for disseminating the results of researches, while the Latin-American universities would benefit by having made available to them the accumulated results of experience and research in the United States on highway finance, design, construction and maintenance.

British Engineer Studies Roads and Rapid Transit in U. S.

Sir Henry P. Maybury, Director-General of the Roads Department, Ministry of Transport of the British Government, and recently elected chairman of the London and Home Counties Traffic Advisory Committee, has just returned to England after spending nearly a month inspecting the highways of the eastern part of the United States and studying the rapid transit situation in several of the larger centers here. Sir Henry during the war was a brigadier-general in the British Army and had the title of director of roads, in which capacity he was responsible for the unkeep and construction of some 4,000 miles of roads and kindred works of vital importance to the transportation of the armies. After the war, when the Road Board of Great Britain was absorbed by the Ministry of Transport, he was appointed director general of roads in charge of the Roads Department of that Ministry. In that capacity he has been one of the major factors in the large road-building program now under way in Great Britain.

More recently, he has been made chairman of the London Traffic Advisory Committee which is concerned partly with traffic in London but more especially with the entire transit problem in the greater city of London. The committee was appointed in the hope that it could find some way out of the maze of the London transit situation which is complicated by the enormous development, some say over-development, of the bus system, to the financial loss of the tramways or street railways and is further complicated by the fact that the municipality has a certain ownership in all of the different transit facilities.

In his study of transit, Sir Henry Maybury spent a considerable time in New York City, in Detroit, Chicago, and Boston. During his visit he traveled over 3,000 miles of the major highways of the country in his study of the road problem.

Court Rules on Appointment of Highway Engineers

The Attorney General of Missouri has ruled that the Missouri State Highway Commission may appoint whatever assistant state highway engineers as may be needed at a salary limit of $5,000 a year. Heretofore the law has been construed as limiting the commission to one assistant chief engineer at $5,000 per year, and the salaries of other engineers employed by the commission was restricted to an average of $3,500 per year.

The Missouri commission has lost the services of many excellent engineers because of the former restrictions on its payroll.

Tidal Power Plan Approved by Voters in Maine

Company to Develop Power From Bay of Fundy Tides Incorporated by Special Act

As noted briefly in our issue last week, voters in the State of Maine by a referendum on Sept. 14, 1925, approved the project to develop tidal power in Passamaquoddy Bay on the international boundary between Maine and New Brunswick by "an act to incorporate Dexter P. Cooper, Inc., for the purpose of developing and utilizing the power of the tides in the Bay of Fundy and waters adjacent thereto."

The objects for which the corporation is formed are: To develop and utilize the powers of the tides in the Bay of Fundy near Eastport in Maine; the project being located partly in Maine and partly in New Brunswick; to construct dams in Cobscook Bay, Passamaquoddy Bay, and such other dams, locks and power stations as may be necessary to develop tidal power and to utilize such power for manufacturing purposes.

The bill provides that the corporation shall not exercise any of the powers granted unless and until the allocation of power generated between the United States and the Dominion of Canada shall be determined by the International Joint Commission, except that the corporation may perform the necessary preliminary work for the preparation of its plans.

Export of Power

In order to comply with the provisions against the general export of power from the State of Maine and still make it possible for the company to dispose of power outside of the state, the act provides that power may be sold and transmitted outside the state in such quantities as shall be approved by the Public Utilities Commission and in such manner as shall preserve to the state the right, after due and ample notice and hearings thereon, to enlarge, diminish and otherwise regulate the amount of such power to be permitted to be sold outside the state as may be deemed necessary to provide adeq. ately for the necessities of the people of the state. No power whatever shall be sold outside of the state except as may be from time to time determined by the commission to be in excess of demands within the state. The law also states that it shall not be lawful for the corporation to transmit electric current generated in any other manner than by tidal power beyond the limit of the state.

The act provides that the corporation shall, within ten years after the act takes effect, complete the initial construction of its work, otherwise the act shall become null and void. "The initial construction shall mean the construction of its dams and other facilities to such extent as will produce sufficient power which when sold shall yield sufficient revenue to cover the operating costs of the production of such power." Rights to power not developed within a further period of 20 years shall lapse.

Program for Railway Bridge and Building Convention

Subjects of special interest to railroad engineers are included in the program for the 35th annual convention of the American Railway Bridge and Building Association, to be held at Buffalo, N. Y., on Oct. 20 to 22. In addition to addresses by R. H. Aishton, president of the American Railway Association, and Frank H. Alfred, president of the Pere Marquette R.R., there will be special illustrated papers on "Erection of the Michigan Central R.R. Arch Bridge at Niagara Falls," by H. Ibsen, special bridge engineer for the M. C. R.R., and "Bridges and Structures of the D., L. & W. R.R." by George J. Ray, chief engineer. Technical reports and papers will include the following: "Precast Concrete Units for Bridge Construction and Maintenance," by T. H. Strate, C. M. & St. P. Ry., "Treatment of Water for Locomotive Use," R. C. Bardwell, C. & O. Ry.; "Electric Operation of Water Stations," J. M. Fitzgerald, C. of Ga. R.R.; "Creosoted Timber for Bridges and Structures," I. L. Simmons, C., R. I. & P. R.R.; "Application of Protective Coatings to Structural Steel," E. F. Manson, C., R. I. & P. R.R.; "Metal Window Sash for Railroad Buildings," F. N. Graham, D. M. & N. Ry.; "Economic Methods for Minor Maintenance Jobs," F. W. Hillman, C. & N. W. Ry.; "Motor Cars for Bridge and Building Gangs," H. N. Huntsman, Wabash Ry. The president of the association is J. P. Wood, Pere Marquette R.R.; secretary, C. A. Lichty, C. & N. W. Ry., Chicago.

Lake Pontchartrain Land and Shore Development Undertaken

The State of Louisiana, and the city of New Orleans, through the Board of Levee Commissioners of the Orleans Levee District, is about to undertake a development of the southern shores of Lake Pontchartrain just north of the city of New Orleans. The initial development will comprise some 2,000 acres of reclaimed land extending from what is known as West End to the entrance of the Industrial Canal. The reclaimed land will be protected by seawalls and jetties and will be subdivided into parcels of land, parks, etc., for city development.

It is estimated that the whole project will cost in the neighborhood of $27,000,000; the item for dredging alone will amount to 35,000,000 cu.yd.

Plans of the Orleans Levee Board for the initial work on the development, which is known as Unit No. 1, include 10,000,000 cu.yd. of dredging.

Beaver County Plans Ohio River Bridge at Ambridge

Plans are being drawn by the commissioners of Beaver County, Pa., for a bridge over the Ohio between Ambridge and Woodlawn. The commissioners have retained T. J. Wilkerson, formerly bridge engineer for the city of Pittsburgh and later consulting engineer to Allegheny County for the design of the structure.

WASHINGTON NOTES

PRESIDENT COOLIDGE will stand behind the Interior Department in its determination to embark on no new reclamation projects until their feasibility has been shown. This may be concluded definitely from clear White House indications. The President is giving the reclamation situation personal attention, no doubt in part because of published statements that a group of Western senators and representatives would urge him to remove Dr. Work, the Secretary of the Interior.

It is known that President Coolidge has gone carefully into the subject and is convinced that it is unfair to the conscientious settler to allow others to repudiate their obligations. Debts to the government, he thinks, should not be subordinated to private obligations. He has been advised of the pressure brought to bear on water users by their private creditors who would absorb all their surplus funds leaving them nothing to apply on their commitments to the government.

Mr. Coolidge is aware of the fact that nearly $9,000,000 of uncollected charges have accumulated during the past five years. He is thought to fear the discrediting and demoralization of federal reclamation unless the tendency toward repudiation can be checked. He is fully informed in regard to the organized efforts in some quarters looking to the evasion of payments. He knows that the new projects over which the differences have arisen will carry a per-acre construction charge more than one half greater than those of the older projects, and even there the settlers are having great difficulties in meeting their payments.

STATES of the upper Colorado river basin are being criticized because of their formal action taken in opposition to the extension of any rights on the Colorado river until the compact has been made effective. There has been little sympathy for the attitude of Arizona in refusing to sign the compact, but the feeling is that there is even less to be said in justification of this action of the upper states.

The indications are that this step was taken to influence the decision of the Federal Power Commission which will meet Oct. 20, to pass upon the Girand license covering the important development at Diamond Creek, which is to be the source of power for the Arizona Copper mines. The license covering this project has been withheld for nearly three years when the commission really was under moral obligations to issue it, apparently with the idea of being abundantly generous to the upper states and of giving them further opportunity to present valid reasons why the license should not be issued.

It looks very much as though the upper valley states simply are trying to get the departments in Washington to take action which will relieve the upper states from the consequences of the decision of the Supreme Court in the Colorado-Wyoming suit. This decision held that the doctrine of prior appropriation of water does not stop at the state boundary. Ever since that decision was handed down the upper states have been trying to escape its consequences, by some means other than to enter into an agreement as to the disposition of the waters of the river.

One of the conditions of any license that may be issued to Mr. Girand is that his right to use water shall be forever junior to the right to use water above him for irrigation or domestic purposes, regardless of the date of the initiation of rights or of use. The upper states fear that such conditions cannot be made legal or binding. It appears to be a fact, however, that if the use of the water in the upper basin did in fact deplete the amount to which Girand otherwise would be entitled under his Arizona appropriation and he should undertake to prevent any depletion regardless of the limitation in his license, his only recourse would be in courts of Colorado or other upper basin states. The moment that he would go into a court of equity and attempt to take out an injunction against the cause of the depletion, he would be met with the terms of his license, the acceptance of which gave him his only rights. Under such conditions he would have no standing in any court of equity when his only occasion for being there was a violation of an agreement.

While the upper basin states wield powerful political influence, the feeling, as this is written, is that the commission will order the license issued to Mr. Girand.

INVESTIGATION of the General Electric Co. by the Federal Trade Commission only now is getting under full headway. Since the beginning of the fiscal year when the completion of other investigations released personnel for this work, the vacation season has been in progress. This not only has depleted the Commission's staff, but has taken representatives of the electrical industry out of their offices to such an extent that the field work has been conducted with difficulty.

AN IMPORTANT ruling made by Attorney-General Sargent last week defines the conditions imposed by the reclamation appropriation laws passed at the last session of Congress. Western interests who favor immediate construction of these projects have argued that the appropriations are mandatory and require the Department of the Interior to proceed with construction. However, the Secretary believed that he was required by law to find the project feasible, before starting work. This view is upheld by the Attorney-General.

The ruling, which related specifically to the Baker (Ore.) project, cites the provision of the Reclamation Act of 1902, which makes construction contingent "upon the determination by the Secretary of the Interior that any irrigation project is practicable," and the provision of an amendment included in the Second Deficiency Act, of Dec. 5, 1924, which requires the Secretary to "have made a finding in writing that it is feasible . . . and that it will probably return the cost thereof to the United States." The Attorney-General concludes that if the Secretary finds that the Baker project is not a feasible project "I believe it is your duty to withhold the beginning of construction and to lay the matter before Congress."

Random Lines

"A Little Knowledge"

A correspondent is worried for fear we are going to transfer this department to the cover of *Engineering News-Record* because we printed there some weeks ago "Rio Grande River." These purists annoy us. We stand firmly by the principle that language is intended to be a vehicle of thought. "Rio," so our friend informs us, means "river" to Spanish students and "Rio Grande" in its native origin, "Great River." Well and good, but "Rio Grande" when applied in English text to the stream which bounds Texas is a name just as Mississippi is a name and in these columns "Rio Grande River" has no more tautological sin than "Mississippi River." Further than that, pedants to the contrary notwithstanding, if occasion arises we will write "*the* hoi polloi," "*the* El Capitan cigar," and "puree mongole *soup*."

* * *

The Clothes Proclaim the Man

The "Members News Letter" of the associated general contractors reports that "When Tom Johnson, of Eagle Grove, Ia., and O. M. Gallefald, of Forest City, Ia., arrived in Lees Summit in a taxicab an hour or so before the sewer and waterworks letting, recently, in order to file their bids on this project, they were promptly arrested by the Sheriff and returned to Kansas City for identification as bandits who had held up the cashier of the Pullman Co. in the Union Station in Kansas City. The cashier could not identify them and they were released, but only after bids were opened on the Lees Summit project."

They should have dressed like engineers. Any sheriff would have known then that they were not dressy enough to be bandits.

* * *

Quick Estimating Required

"The board of supervisors of the Town of Wood River will meet at the home of Enock Wistrom, on the 24th day of Aug., at 2 o'clock in the afternoon, to let contract for ditching and grading on new road. Further particulars concerning the work will be made known at the meeting. The board reserves the right to accept or reject any or all bids.

Dated Aug. 8, 1925.

TOWN BOARD OF SUPERVISORS"

One wonders, says a correspondent, why the Board considered it necessary to condescend to make known further particulars at all.

Newark Engineering Department Reorganized

The engineering department of the city of Newark, N. J., a city having a commission form of government, has been reorganized by the mayor, who is also head of the Department of Public Affairs. Under the arrangement which has been in effect in the past, the three divisions of this department, the Division of Works, the Division of Water and the Division of Surveys, each had a chief engineer, all of equal rank. Under the new arrangement, there will be but one chief engineer who will be the chief engineer of the Department of Public Affairs, with the engineers at the head of the three divisions reporting to him. The title of the three engineers has not been determined.

In making the change, the mayor appointed James W. Costello, formerly chief engineer of the Division of Works, as acting chief engineer of the Department of Public Affairs, and subsequently John A. Foulks, chief engineer of the Division of Water, and Harrison R. VanDuyne, chief engineer of the Division of Surveys, resigned.

Mr. Costello has been in the employ of the city of Newark since 1918, when he was appointed engineering supervisor of the Bureau of Street Cleaning and Refuse Collection. In 1921 when the departments were reorganized, he was appointed head of a newly created Division of Works, at the same time that Mr. VanDuyne was appointed head of the Division of Water and Mr. Foulks of the Division of Surveys. Prior to his appointment, Mr. VanDuyne had been assessment commissioner and deputy chief engineer of the Department of Streets and Public Improvements, when the present mayor was director of that department. Mr. Foulks came to the Division of Water after having been civil service commissioner for a short time. Previously he had been with the New Jersey Highway Department.

Steelwork Contract Let for Part of Montreal Bridge

Contract for the construction of the steelwork of the Montreal-South Shore bridge has been awarded to the Dominion Bridge Co. The contract for the substructure of this portion of the bridge was let some time ago and the work is well under way.

Contract for the substructure of the north portion of the bridge was let recently to the Dufresne Construction Co., Ltd., and work will be commenced immediately.

It is not expected that steelwork erection will begin at the bridge until next spring.

Cannot Agree on Incinerator Site

The voters of Lynbrook, N. Y., authorized $60,000 of bonds for an incinerator some time ago but on Sept. 19 they voted 676 to 353 against the site chosen by the local authorities. The health authorities of Nassau County have ordered the abolition of town dumps by April 1.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Montreal, Que., Canada, Oct. 14-16, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION, Chicago, Ill.; Annual Convention, Buffalo, N. Y., Oct. 20-22, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Lakeland, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-30, 1925.

CITY MANAGERS ASSOCIATION, Lawrence, Kansas; Annual Convention, Grand Rapids, Mich., Nov. 17-19, 1925.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Detroit, Mich., Nov. 18-20, 1925.

HIGHWAY RESEARCH BOARD, Washington, D. C., Annual Meeting of the Highway Research Board, Washington, D. C., Dec. 3-4, 1925.

The Russian Association of Engineers will open its season of activities with a meeting Sept. 30, 1925, at the Engineering Societies Building, New York City. The principal speaker at this meeting will be Leon S. Moisseiff, engineer of design of the Delaware Bridge, who will talk on The Construction of the Delaware Bridge.

Florida Chapters of the American Association of Engineers met at Orlando, Fla., Sept. 12, to consider the consolidation of the five Florida chapters of the association into a class A chapter covering the entire state.

The Washington State Good Roads Association at its recent twenty-sixth annual session in Hoquiam, Wash., elected the following officers: President, Claude C. Ramsey, Seattle; vice-presidents, E. L. French, C. F. Stinson, A. L. Rogers, F. J. Wilmer and Leon E. Titus. Douglas A. Shelor, Seattle, is secretary.

Personal Notes

D. C. SOUTHWORTH has been appointed chief engineer of the Chicago, South Bend & Northern Indiana R.R., with office at South Bend, Ind.

H. J. KUELLING, design engineer of the Wisconsin Highway Commission, Madison, Wis., has resigned and will enter the practice of consulting engineering at Milwaukee, Wis.

H. W. VAN HOVENBERG, sanitary engineer of the St. Louis Southwestern Ry., Texarkana, Texas, has been appointed consulting sanitary engineer of the Rock Island Lines, holding both positions and carrying out similar work on the two railroads. The work on the Rock Island Lines will be very similar to that which the St. Louis Southwestern Ry. has prosecuted for several years, particularly for malaria control in Arkansas, Louisiana and Texas and for the improvement of the health and working conditions of the employees by eliminating insanitary conditions over the entire system.

R. L. PINKLEY, engineer of way and structures, Milwaukee Electric Railway & Light Co., Milwaukee, Wis., has been appointed vice-president of the company. He is succeeded by E. J. ARCHAMBAULT, formerly assistant engineer of way and structures.

JOHN E. KERANEN and ALLEN H. FINLAY have been appointed to the research graduate assistantships in highway engineering at the University of Illinois, recently established by the Austin Mfg. Co. for the study of gravel and earth roads. Mr. Keranen is a graduate of Washington State College in the class of 1923 and since then has spent a year at the University of Illinois in post-graduate work and sixteen months as assistant county engineer of Whitman County, Wash. Mr. Finlay is a graduate of the University of British Columbia in the class of 1924 and has served about 1½ years as assistant division engineer on the Canadian Pacific Ry.

JOHN A. FERGUSON, a consulting and architectural engineer of Pittsburgh, Pa., who recently had been engineer for the building code commissions for several cities and who has specialized in preparing construction and design standards and systems and in planning buildings and structures for the proper and efficient use of construction materials, has joined Mellon-Stuart Co., contracting engineers, of Pittsburgh, Pa.

S. O. HARPER, formerly superintendent of the Grand Valley Project, has been made general superintendent of construction of the Bureau of Reclamation with offices in Denver. J. C. PAGE becomes superintendent of the Grand Valley Project which has offices at Grand Junction, Colo. Mr. Harper is a graduate of the University of California in the class of 1907 and entered the Reclamation Service the same year as a junior engineer on the Uncompahgre Project at Montrose, Colo. He first went to the Grand Valley Project in 1908 becoming assistant engineer in 1910.

Obituary

ARTHUR R. HENRY, consulting civil engineer, Montreal, died suddenly in that city Sept. 8, aged 53 years. Mr. Henry was a graduate of Cornell University and had practiced in consulting engineering in Montreal for twenty years.

ROSCOE COOK, 58 years old, road contractor of Wabash, Ind., died recently at his home of heart disease.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

To Stage Western Road Show in Five Large Tents

Up to Sept. 10 125 exhibitors had signed up for the "All-Western Road Show" for the week of Nov. 9-14 at San Francisco. Exhibits will occupy 124,000 sq.ft. in five large tents. The show will be located near the 1915 Exposition grounds in a 30-acre tract in which the entire area not occupied by tents will be available for outdoor demonstrations where road building equipment can be operated under its own power. A part of the tract consists of rough ground where excavated material has been dumped and where power shovels and similar equipment can be demonstrated; the remainder is level and can be used for graders, rollers, etc.

In addition to the variety of road-building machinery to be exhibited there will also be equipment for allied construction work. For example, power shovels and cranes for railroad contractors, trench excavating and back-filling machines for sewer builders, crushers and concrete machinery for dam construction, drilling and mucking machinery and locomotives for tunneling, as well as drag lines and excavators for canal construction. Principal emphasis, however, will be placed on road-construction equipment. The total value of the exhibits, it is stated, will exceed $1,500,000.

All five tents will be grouped at the north end of the 30-acre tract and in each tent the displays will be arranged to keep similar equipment together. Transportation exhibits including motor trucks, dump trucks, hoists, Fordson attachments, etc., will occupy an entire tent containing 24,000 sq.ft. of floor space. As more exhibitors want space additional tent units can be added. This plan makes it unnecessary to crowd exhibits and affords as much area as may be desired.

A convention committee is making provision for a series of meetings for which addresses, papers and discussions are planned. The program includes a day for each of the following classifications: engineers, contractors, county commissioners and distributors. Special features of the program will conclude with a banquet on Friday night.

P. H. Curtis is executive secretary and has offices at 625 Market St., San Francisco.

Southwest Water-Works Convention in Tulsa, Oct. 12-15

The thirteenth annual convention of the Southwest Waterworks Association will be held in Tulsa, Okla., at the Mayo Hotel, Oct. 12-15. An equipment exhibit will be held in conjunction with the technical sessions, space being provided in the ballroom of the hotel. J. E. O'Leary, 50 Church St., New York City, is chairman of the exhibit committee.

Equipment Exhibit to Be Held at International Exposition

The Sesqui-centennial International Exposition which will be held in Philadelphia from June to December 1926 to commemorate the 150th anniversary of the signing of the Declaration of Independence wil have as one of its features an exhibit of road building machinery and equipment.

President Coolidge has appointed Secretaries Kellogg and Hoover to represent the U S. and has invited all nations to participate thus giving the exposition an international character. The officials of the exposition feel that a great deal can be done towards speeding up the road building program in America by giving special atention to a road building exhibit. D. C. Collier, is director general of the Sesqui-centennial Exhibition Asociation, Inc., with offices at Independence Square, Philadelphia.

Business Notes

HEBER G. STOUT, export manager, Chain Belt Co., Milwaukee, has recently returned from a six months' tour of South America, made in the interests of his company.

HAYNES STELLITE CO., New York, manufacturer of metal cutting tools, has just completed concentration of the company's activities at its plant at Kokomo, Ind. Further service in connection with the company's product will be extended direct from this plant, which is under the direction of C. G. Chisholm, general manager.

GEORGE HAISS MFG. CO., New York City, is now completing a new addition to their plant, which will add 40,000 sq.ft. of floor area. The new addition is a one-story building 28 ft. high and 150 by 225 ft. in plan. It is to be used as a machine and assembly shop.

R. E. BROOKS CO., 50 Church St., New York City, has superseded Ginsberg-Penn Co. as representative of A. W. French & Co., manufacturers of concrete road finishers.

W. A. JONES FOUNDRY & MACHINE CO., Chicago, manufacturer of power transmitting machinery, has appointed F. S. Van Bergen as district sales manager at Minneapolis. He will cover the territory of Minnesota, North and South Dakota, and adjacent parts of Iowa and Wisconsin.

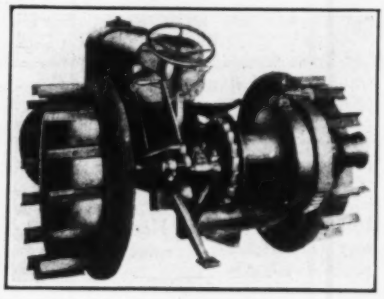
O. C. DAHLMAN, advertising manager, Koehring Co., was elected president of the Milwaukee Industrial Advertisers Association at the annual meeting recently. Other officers elected were H. P. Sigwalt, advertising manager, Milwaukee Corrugating Co., vice president and Delbert Kay, advertising manager, Nordberg Mfg. Co., secretary.

UNIVERSAL PORTLAND CEMENT CO., Chicago, announces the appointment of E. B. Harkness as secretary and A. W. Carlisle as treasurer to fill the position recently left vacant by the death of T. J. Hyman, former secretary and treasurer. O. N. Lindahl, auditor, has assumed the further duties of assistant secretary.

Equipment and Materials

New Improvements on Fordson Hoist Attachment

The Fordson hoist attachment manufactured by the Clyde Iron Works, Duluth, Minn., has been improved for heavier work. The hoist frame is fastened to the tractor by eight of the bolts that connect the rear axle housing and the transmission housing and three bolts through holes in the drawbar cap. It is further held rigidly in place by guy rods. The hoist frame is equipped with a draw bar lug so that the tractor may be used for hauling without removing any part of the hoist.



A winch head can be placed on all the sizes of hoists.

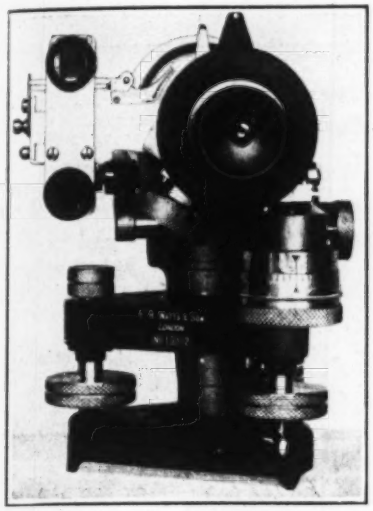
The power is applied through a roller chain drive from the pulley shaft upon which a sprocket is installed in place of the pulley. A rod placed on the lever side of the hoist gives the operator full control of the throttle. The drum is friction driven and equipped with an asbestos-lined brake brand which is operated by a foot pedal.

The hoist is built in three sizes, with line pulls of 4,000 lb. at 175 ft. per min.; 4,700 lb. at 150 ft. per min., and 5,600 lb. at 125 ft. per min. The drum barrel has a capacity of 600 ft. of ½ in. cable.

Precise Level Has Only One Adjustment

A precise level manufactured by E. R. Watts & Son, Ltd., London, England, presents several new features which are claimed to add greatly to its accuracy and convenience. In the first place, the 11 in. telescope with its attached bubble can be tilted independ-

ently of the vertical axis. In setting up, the vertical axis is brought approximately vertical by foot screws and two small cross bubbles. Final adjustment is by the differential tilting screw on the telescope. The bubble is "constant" that is, does not change its length with change of temperature. Thus only one end of the bubble need be observed when setting.

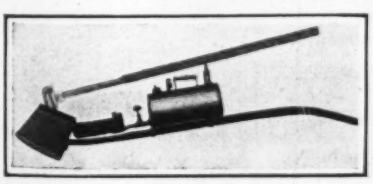


The only adjustment necessary is in the attachment of the bubble to the telescope. This can be easily made in the field in a few minutes because the bubble is reversible being graduated on both sides in such a manner that the graduations are guaranteed parallel within 2 seconds of arc. The method of adjustment by a reversible bubble is old but it is claimed that it is only the introduction of the constant bubble that enables its full benefits to be obtained.

The telescope is of the internal focusing type equipped with stadia lines (1:100). Where leveling work of high precision is required, a special parallel plate micrometer can be applied which enables the staff graduations to be bisected by the cross hair and the third decimal place to be read off with accuracy.

Asphalt Smoothing Iron Is Self Heating

A new asphalt tool recently produced by the Chausse Oil Burner Co., Elkhart, Ind., is a self-heating asphalt smoothing iron. The device is a combination of a standard smoothing iron and a portable torch. A small heating chamber is attached to the smoothing iron, into which the flame from the torch is directed, and it is possible to use this for heating a tamping tool.

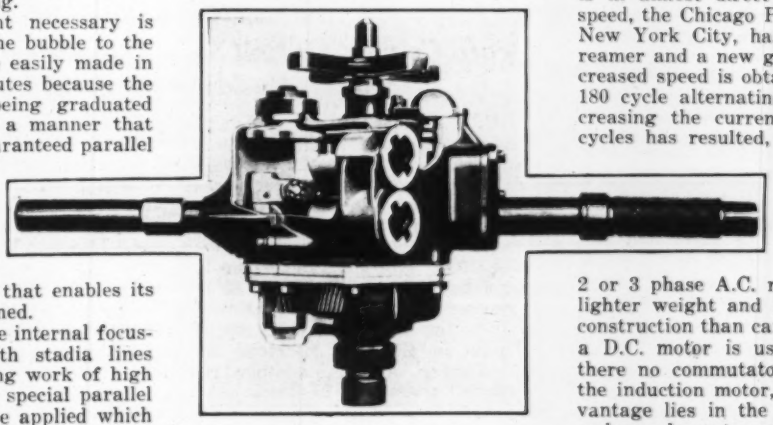


The torch will burn in any position and has a capacity of 3 gal. of kerosene. It can be detached and used for other purposes such as heating cold joints, melting tar, heating asphalt machinery, and in any service where 1,800 deg. of heat or less is desired. The smoothing iron is always at the proper heat, and can therefore be used constantly without the necessity of changing tools.

Speed Governors Used on Pneumatic Drills

The new line of long-stroke four-cylinder pneumatic drills manufactured by the Ingersoll-Rand Co., New York, are equipped with speed governors which automatically prevent racing the drills beyond a safe working speed. The governor is also claimed to reduce air consumption; in tapping and reaming work it avoids burning of taps and reamers.

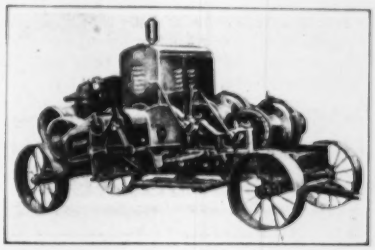
Removable cylinder liners are used so that a worn cylinder may be renewed at small cost. Crank pins are fitted with a sleeve held stationary on the crank pin; the sleeve is consequently the only part requiring renewal. In order to eliminate the conditions caused by the tendency of the grease to fly away from the crank pin by centrifugal force, crank pins are lubricated from the inside as well as from the outside.



Gearing is of helical type and the connecting rods are one-piece drop forgings. The main valve is of large diameter and is air balanced. The complete line of drills is available in both reversible and non-reversible types.

Hoist and Air Compressor Mounted on Same Chassis

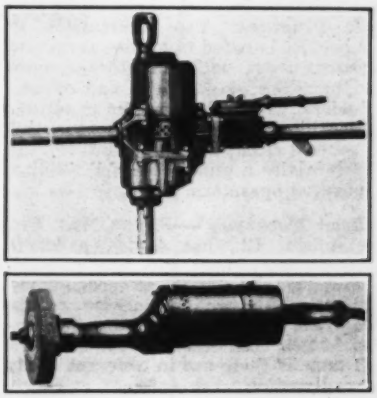
Indicative of a comparatively new tendency in the design of contractor's construction equipment is the combination hoist and air compressor unit manufactured by the Novo Engine Co., Lansing, Mich. The hoist is gear driven from the engine while the compressor is operated by a short belt. This specific combination is especially useful in structural steel work on buildings, bridges and tanks where hoisting of steel, riveting and calking are the major operations. Four cylinder engines of 18, 25 and 40 hp. respectively are used on the different size units. Hoists with line pulls of 2,700 to 4,000 lb. and speeds of 175 to 250 ft. per min. are available for different requirements. The air compressor is of the vertical duplex single acting water-cooled type. Capacities vary from 90 to 170 cu.ft. of free air per min. at 100 lb. per sq.in. pressure on the various models of the unit. Separate cooling systems are provided for the engine and compressor and the outfits are built either with or without air receivers.



Increase Power of Electric Tools by Using 180 Cycle A.C.

By utilizing the principle that the power developed under load by any electric tool with a given size of armature is in almost direct proportion to the speed, the Chicago Pneumatic Tool Co., New York City, has developed a new reamer and a new grinder in which increased speed is obtained by the use of 180 cycle alternating current. By increasing the current from 60 to 180 cycles has resulted, it is claimed in a 300 per cent increase in speed. It is also claimed that the use of an induction motor which operates on 2 or 3 phase A.C. results in a tool of lighter weight and greater rigidity of construction than can be obtained when a D.C. motor is used. Not only are there no commutators and brushes in the induction motor, but a further advantage lies in the fact that the secondary element, usually the rotor in the induction motor, cannot be burned out whereas both the armature and field coil of the D.C. motor are subject to this damage.

The speed of the tools is practically constant, there being a variation of only 8 per cent from no load to full load. In



order to operate these "Hicycle" tools a special generator is required to furnish the current at 180 cycles, 220 volts, 3 phase, which has been adopted as standard. The frequency lends itself nicely to 60 cycle induction motor drive, being a multiple of 60 cycles, so that direct connected generator sets can be supplied economically.

Publications from the Construction Industry

Air Compressors — PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., has issued three new bulletins. The first No. 122, describes after-coolers for cooling and drying the air after it is compressed and before it is delivered into the service pipe. Bulletin 123 treats of air compressors and vacuum pumps of straight line, single stage and double acting type. The third, No. 124, specifically describes the company's portable air compressor unit.

Cranes and Shovels — NORTHWEST ENGINEERING CO., Chicago, has issued a new booklet on crawler equipment. Different sections of the catalog illustrate and describe the equipment at work on highways, sewage and drainage projects, in sand and gravel pits, and in the lumber camps. Specifications are given for gasoline shovels, cranes, draglines, and trench pull-shovels. A list of representative owners is also given.

Highway Construction — WESTERN WHEELED SCRAPER CO., Aurora, Ill., has issued a booklet on industrial haulage systems for concrete road building. Besides describing batch-boxes, road builder's trucks, dump cars, and industrial railway trackage, the booklet gives several pages of snapshots showing this equipment in use on road building projects.

Hydraulic & Sanitary Equipment— THE SANITATION CORPORATION, New York City, has called its new bulletin G-12 "Gates, Valves, and Control Apparatus for Water and Sewage." The catalog contains 23 pp. and describes and illustrates a variety of types of weir gates, circular gates, trash screens and sewage ejectors.

Welding — OXWELD ACETYLENE CO., Long Island City, recently published a small booklet entitled "Precautions and Safe Practices." The information in the booklet is listed in outline form and concerns itself with the storage, care and handling of acetylene and oxygen cylinders, with safe practices in setting up welding and cutting apparatus, and in general safety recommendations. It is essentially a guide book for welding apparatus operators.

Road Machinery — BAKER MFG. CO., Springfield, Ill., has issued a 32 p. catalog describing its line of self-loading, tractor-drawn scrapers. Illustrations are given of machine details and of construction operations in addition to text that describes the scrapers and tells of their use in different kinds of construction work.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago— Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
September 24, 1925	$24,934,000	$17,918,000	$42,852,000
September 17, 1925	28,860,000	45,006,000	73,866,000
September 25, 1924	22,837,000	14,130,000	36,967,000
Heaviest Week			
1925, Sept. 3	16,215,000	69,424,000	85,639,000
1924, May 8	26,370,000	38,829,000	65,199,000
January 1 to Date			
1925	803,104,000	1,051,526,000	1,854,630,000
1924	768,988,000	768,698,000	1,537,686,000

Record Cement Output Shows Confidence in Continued Building Demand

AUGUST cement output and shipments were the highest recorded for any single month in the history of the industry, according to latest reports of the Bureau of Mines.

Production gained 8 per cent and shipments 9 per cent, compared with August, 1924. Mill stocks continue the seasonal decline but are nearly 12 per cent greater than at this time last year.

In July, the cement industry opened new mills in Georgia, Michigan and Ohio. During August, another new mill started operations in Ohio.

Following is a record of cement production and shipments Jan. 1 to Sept. 1, this year and last:

	Production		Shipments	
	1924 Barrels	1925 Barrels	1924 Barrels	1925 Barrels
Jan.	8,788,000	8,858,000	5,210,000	5,162,000
Feb.	8,588,000	8,255,000	5,933,000	6,015,000
Mar.	10,370,000	11,034,000	8,995,000	10,279,000
April	11,726,000	13,807,000	12,771,000	14,394,000
May	13,777,000	15,503,000	14,551,000	16,735,000
June	13,538,000	15,387,000	15,936,000	17,501,000
July	14,029,000	15,641,000	16,614,000	18,131,000
Aug.	15,128,000	16,419,000	16,855,000	18,383,000
Total 8 mos.	95,944,000	104,902,000	95,965,000	106,600,000

Reserve mill stocks, for the entire country, at the end of each month, follow:

	1924 Barrels	1925 Barrels
January	14,155,000	17,656,000
February	16,815,000	19,689,000
March	18,189,000	20,469,000
April	17,159,000	19,377,000
May	16,403,000	18,440,000
June	14,903,000	16,409,000
July	12,319,000	13,696,000
August	10,666,000	11,931,000

The continued expansion of the cement industry and its record achievements in output and production show unmistakable confidence in the immediate future of concrete construction.

The heaviest producing and likewise shipping sections of the country are eastern Pennsylvania, New Jersey and Maryland, followed closely by Wisconsin, Illinois, Indiana and Kentucky. The bulk of the reserve stocks, however, are in Wisconsin, Illinois, Indiana, Kentucky, eastern Missouri, Iowa, Minnesota and South Dakota. The three heaviest consuming states, in order are New York, Pennsylvania and Illinois.

From Jan. 1 to Aug. 1, 1925, there were 1,541,607 bbl. imported from foreign mills, valued at $2,419,171, against 1,092,326 bbl., valued at $1,649,605 for the corresponding period last year.

Exports during that period were 537,470 bbl., valued at $1,608,431, compared with 548,669 bbl., valued at $1,608,692 in 1924.

In the following tabulation July imports are compared with domestic shipments to the same territory:

SHIPMENTS

To	From	Barrels
Massachusetts	Belgium	34,649
	Norway	5,981
	U. S.	386,058
Florida	Belgium	51,574
	U. S.	341,849
Main and New Hampshire	Canada	536
	Norway	4,468
	U. S.	83,318
Vermont	Canada	10,045
	U. S.	26,245
Washington	Belgium	8,311
	Norway	14,894
	U. S.	334,466
Hawaii	Belgium	35,846
	Japan	292
	U. S.	1,827
Porto Rico	Belgium	5,897
	Denmark	8,501
	U. S.	17,379

Fewer Business Failures—Increase in Total Liabilities

The number of commercial failures in the United States has shown a decrease from month to month since April, according to compilations of R. G. Dun & Co. The August total of 1,513 is the smallest reported in eleven months. Monthly and quarterly reports, showing number of defaults, are as follows:

	1925	1924
August	1,513	1,520
July	1,685	1,615
June	1,745	1,607
May	1,767	1,816
April	1,939	1,707
2nd quarter	5,451	5,130
March	1,859	1,817
February	1,793	1,730
January	2,317	2,108
1st quarter	5,969	5,655

In money value of liabilities, however, there has been a gain. The August total was 6 per cent greater than that for the month preceding.

Small Drop in Unfilled Tonnage Shows Steady Demand for Steel

IMPROVEMENT in the steel market, with its consequent effect upon trade in general is indicated by the recent gain in ingot production and also by a smaller reduction in the unfilled tonnage than was at first expected.

The output of ingots for the entire country during August, as computed by the American Iron and Steel Institute, was 3,424,000 tons, a gain of 13 per cent over the month preceding and 34 per cent over the corresponding period in 1924.

STEEL INGOT OUTPUT—ALL COMPANIES

	1925 Tons	1924 Tons
January	4,198,564	3,649,913
February	3,756,243	3,826,246
March	4,198,520	4,206,599
April	3,587,524	3,348,466
May	3,458,253	2,640,034
June	3,207,056	2,065,676
July	3,087,590	1,877,789
August	3,424,034	2,552,891
8 months	28,917,784	24,167,714

Unfilled orders on books of the U. S. Steel Corporation, Aug. 31, amounted to 3,512,803 tons, a reduction of 26,664 tons from the forward business on hand, July 31, 1925.

Estimates made prior to Sept. 10, at which date the unfilled tonnage report was issued, revealed expectations of a much greater recession in steel demand than actually happened.

UNFILLED ORDERS ON HAND—U. S. STEEL CORPORATION

	1925 Tons	1924 Tons
January 31	5,037,323	4,798,429
February 28	5,284,771	*4,912,901
March 31	4,863,564	4,782,807
April 30	4,446,568	4,208,447
May 31	4,049,800	3,628,059
June 30	3,710,468	3,262,505
July 31	3,539,467	3,187,072
Aug. 31	3,512,803	3,289,577

* Feb. 29 1924.

Unit Bids Compared on Operations and Materials in Place on Federal Aid Road Projects

Comparative costs of excavation, surfacing, structural concrete, reinforcing steel and common labor, on various Federal Aid road projects, are shown in the following tabulation of unit bids.

These items embrace operations in twelve states and cover four different types of work. Materials were hauled an average distance of from one to five miles to the job. In four instances, however, the hauls were ½-mi., 10-mi., 16-mi., and 95-mi., respectively.

Average costs on these operations, materials in place, were as follows: Reinforced concrete surfacing, at an average thickness of 8½ in., $1.64 per sq.yd.; earth excavation, 52c. per cu.yd.; rock excavation, $2.40 per cu.yd.; reinforcing steel, 5.71c. per lb.; structural steel, 8c. per lb.; common labor, 44.8c. per hour.

The highest rate for common laborers was 56c. per hr., paid in Oregon; with Massachusetts next at 55c. The rate in Idaho, California, Pennsylvania and Washington was 50c. per hr. Wyoming paid 45 to 50c. and Ohio, 40 to 45c., while Wisconsin and Arizona observed a rate of 40c. per hr. The two lowest wage schedules for this type of work were those obtaining in Indiana and Georgia, the former at 30c. and the latter, 20c. per hour.

Bid Prices, Bureau of Public Roads, U. S. Department of Agriculture

County	Contract Let to	Type	Thickness of Surfacing, In.	Unit Prices Bid—Materials in Place: Surfacing Sq. Yds.	Surfacing Unit Price	Excavation Cu. Yds.	Excavation Unit Price	Structural Concrete 1-2-4 Cu. Yds	Structural Concrete 1-2-4 Unit Price	Steel Reinforcing Lbs.	Steel Reinforcing Unit Price	Average Haul, Mi.	Aver. Hourly Wage, Common Labor
IDAHO													
Bingham	Daley & Adams, R.F.D. No. 2, Blackfoot, Ida.	Grading	..	.....	....	31,807 514	$0.235 2.00*	39	$29.00	4,000	$0.085	5	$0.50
MASSACHUSETTS													
Bristol	C. Bianchi, Framingham, Mass.	R. C. C.	8	32,436	$2.45	6,785 385	1.20 3.50*	102	35.00	374,700	.04	1½	.55
OREGON													
Linn & Lane	Geo. W. Read, Eugene, Oregon	Cem. Conc.	..	44,000	1.97	.....	.....	...	.....	16,500	.04½	..	.56
John Day	K. L. Goulter, Port Angeles, Wash.	Grading	..	.....	....	60,700 49,200	.35 1.20*	40	40.00	.....	....	..	.56
WYOMING													
Sublette	J. F. Turpin, Wheatland, Wyo.	Earth	..	.....	....	11,000 50	.33 1.25*	24 30	32.00 28.00†	96,000	.075	95	.50
Johnson	Threet Bros., Lovell, Wyo.	Grav. or Shale	7	.....	....	51,000 150	.23 1.50*	278	24.00	24,500	.07	10	.45
CALIFORNIA													
Nevada	McKay Engineering Co., Los Angeles, Calif.	....	..	.....	....	1,500 370	1.00 5.00*	830	29.30	102,000	.05	½	.50
GEORGIA													
Gilmer	R. L. Killian, Canton	Chert	6	.....	....	30,058	.41	324	23.50	24,187	.06	2	.20
WASHINGTON													
Snohomish	J. A. McEachern Co., Seattle	....	..	.....	....	16,180	.....	1,465	15.50	1,258,000 4,400,000	.04½ .06‡	1	.50
INDIANA													
Fountain	Wm. E. Allen, Hillsboro, Ind.	Graded and Drained	..	.....	....	20,675	.38	...	.....	.....	.....	2	.30
PENNSYLVANIA													
Allegheny	F. F. Hallan & Son, Fairmont, W. Va.	Reinf. Conc.	6	.....	....	.....	.....	23 99	46.00 19.00†	2,481	.08	3	.50
WISCONSIN													
Manitowoc	Peppard, Burrill & Lynch, Milwaukee, Wis.	Concrete	6½	.....	....	37,793	.56	703	20.60	26,524	.05	2	.40
ARIZONA													
Yavapai	Lee Moor Contr. Co., El Paso, Texas	Gravel	6	1,583	.25	7,117	.43	41	15.00	.....	.....	1	.40
OHIO													
Belmont	Stringer & Stringer Co., Wheeling, W. Va.	Reinf. Conc.	9	12,450	.50	.....	.....	102 199	15.00 11.00†	8,937 84,300	.05 .08‡	16	.45
Licking	Lynn Construction Co., Paulding	Reinf. Conc.	9	.....	....	13,120	.60	209 107	20.11 12.03†	27,722 880	.05 .10‡	3	.40
Miami	Stout & Stout, Stoutville, Ohio	Gravel	11½	380	1.25	3,110	.....	3,110	18.48	329,000	.04	1	.40

* Rock excavation; † 1-3-6; ‡ Structural.

Weekly Construction Market

THERE is a notable lack of serious price fluctuation in the current market for basic building materials. Clay products are tending downward at the present time but this move is believed, by the materials dealers, to be temporary. Structural steel shapes are beginning to show some firmness; cement retains its usual stability.

Lumber is the one material where some qualifying statements are necessary before the market may be said to be going up or down.

Long-leaf yellow pine timbers, 3x12 to 12x12-in., 20-ft. and under, have not changed in price at New York during the past three months. Pine lath is higher with active demand reported in No. 2 common boards, B and Better finish, special cutting and upper grades of flooring.

Regardless of the heavy demand for building materials in the South there is no noticeable up-turn in prices throughout that section. Commenting upon the situation, the Lumbermens' Bureau states that "the yellow pine market has continued to improve gradually during the last month. The outstanding feature has been the difficult situation caused by the embargoes against the Florida markets which have become so important to the trade in the last few months. This situation is being relieved rapidly, however, as the traffic jam is being straightened out and already the embargoes are removed on West Palm Beach and points north."

A brief summary of the iron and steel market follows: Small lot buying characterizes the iron market; price of No. 2 fdry. Southern is up 50c. per ton from last week's level, making the second consecutive rise of this kind in two weeks. Coke continues upward. Steel shapes are firmer at $1.90@$2; bars are at about the same level and plates remain at last week's quotation of $1.80@$1.90 per 100 lb. Pittsburgh.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.90	$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb	3.24	3.40	2.80	3.00	3.25	3.62½	3.35	3.25	2.30
Steel pipe, black, ⅜ to 6 in. lap, discount	48%	58%	53.6%	51%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	46.00	54.00	49.20@50.20	53.00	63.00	+54.00	53.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.25	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd	1.75	2.20	2.38	2.00@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd	1.00	1.65	2.00	2.00@2.20	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.20	2.83	2.00@2.20	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59.00	34.00	58.50	45.00	38.75	33.75	27.00	24.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	18.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.25@2.75	1.30	1.85	1.45	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	—17.50@18.00	10.50	11.60	12.00	13.50	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0893	.10	.075	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1162	.0893	.10	.075	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal	1.08	+1.15	1.13	+1.05	1.14	1.27	1.15	1.12	1.25
Common Labor									
Common labor, union, hour	.55@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.50@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93⅞c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of September 3, the next on October 1.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Business Briefs

Call money quoted at 4½@6 per cent, Sept. 21: Year ago, 2 per cent.

Time loans: short periods, 4½ per cent; longer terms, 4¾ per cent.

Commercial paper: best names, 4¼ per cent; other names, 4½ per cent.

On September 1, 1925

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For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month